POWER

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Disillusionment

A CROWD of children stand and sit upon the village green watching a Punch and Judy Show, following with wondering eyes the antics of the animated puppets as they work out the age-old comedy.

But one, with more interest in the stagecraft than in the story, with more wonder as to how the thing works than as to the outcome of Punch's deviltry, sneaks behind the cabinet, thrusts an inquisitive head between the curtains and discovers the manipulator.

Life is more or less of a Punch and Judy Show. Most people prefer to sit out front and take it as it is fed to them.

A play is never quite the same to one who has been behind the scenes.

Too much analysis and disillusionment take away a lot of its zest and enjoyment and pathos and glamour.

The inquisitive boy felt vastly superior to his gullible associates and winked with knowingness at his elders who shared but preserved the secret.

The habit has persisted. He takes nothing at its face value. He is always looking for the fellow who pulls the strings, for the facts behind the painted scene.

And needless to say, he has been successful where the credulous or those with a less investigative turn of mind have failed.

But all cannot be leaders of thought, projectors of enterprises, progenitors of isms or defenders of the status quo. If all were wire pullers, they would get their wires tangled. There can be no mass leadership if there are no masses to be led, and there must be popular complaisance even for more or less conscious mummery.

The Punch and Judy Show is better, even to those who know that he is there, because of the curtains that conceal the legs of the operator.

F. R. Low

Lilla Edet Station Has Two Types of Waterwheels

By GEORGE WILLOCK*

THREE waterwheels of 11,200-hp. rating operate under 21-ft. head. All these wheels are of the propeller type, one having adjustable blades and two stationary blades. This combination gives an efficiency of 90 per cent from about 3,000 to 32,000-hp. load.

AT LILLA EDET on the Gotha River in Sweden, the first section of a hydro-electric station is completed, which is eventually to contain seven units of approximately 11,200 hp. each, to operate under a 21-ft. head at 62.5 r.p.m. The present plant contains three units, one of the Kaplan type built by Verkstaden, Kristinehamn, and the other two of the Lawaczeck type, supplied by A. B. Finshyttan. The Kaplan runner is of the high-specific-speed propelled type with the blades arranged so that they can be adjusted to maintain high efficiency over a wide range of load. This unit and its operation were described in *Power* Nov. 13, 1923, and Oct. 12, 1926. This article will deal particularly with the Lawaczeck units.

The guide-vane structure of these units, Fig. 6, differs only slightly from that used with Francis-type wheels. Owing to their large size many of the parts had to be made in sections and bolted together. The 28 cast-steel guide vanes are supported by ball thrust bearings and have white-metal lined guide bearings in the crown plate and discharge ring. These guide vanes are 10 ft. long, without including the length of the spindle. There are holes in the out circumference of the crown plate, Fig. 3, which allow any one of the guide vanes to be removed without disturbing the others.

Owing to their large dimensions the runners offered one of the most difficult problems in the design and construction of the units. The six blades for each runner were made separately and bolted to a boss. Each blade is held in place by eight well-fitted bolts. The blades and boss are of cast steel of a grade so uniform that the difference in weight of any of the twelve blade castings was less than one per cent and four of the blades had practically the same weight. The blades are machined so that they fit against each other on the completed runner, which weighs about 50 tons. A completed runner in the shop is shown in Fig. 2.

A section through the plant and one of these units is shown in Fig. 8. It will be seen that the outside diameter of the runner is 19 ft. 8 in. The intake from the forebay to the wheels has been divided horizontally by a concrete floor as indicated. This prevents the lower current of water from interfering with the upper

*With A. B. Finshyttan, Sweden.

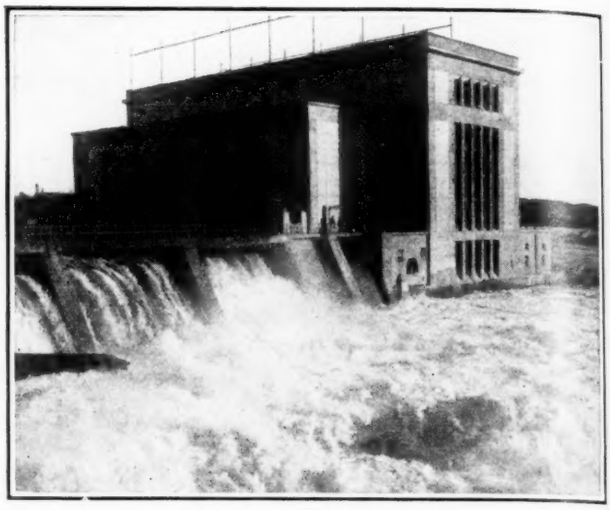


Fig. 1—Initial section of Lilla Edet Station

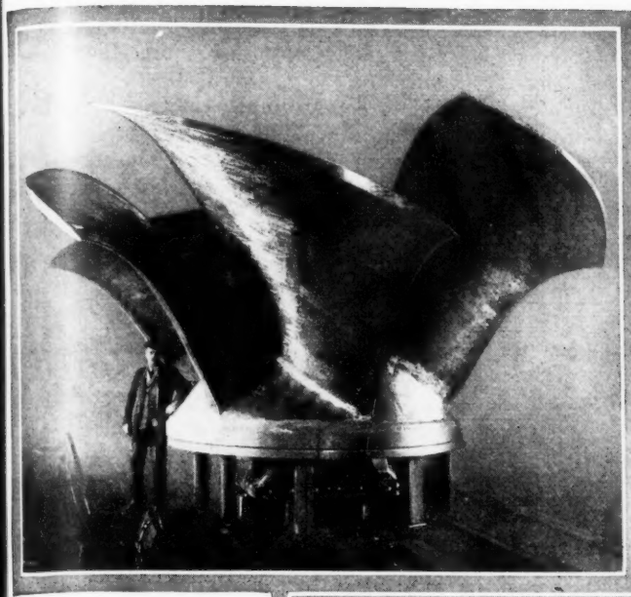
and keeps down the disturbance in the flow to the scroll case. As the intake from the forebay is about 40 ft. deep and that to the turbine only 10 ft., the benefit of dividing the intake horizontally and leading the water two ways to the scroll case is apparent.

One oil pump is provided for the governor on each unit. These pumps are of the geared type, and each has three wheels with teeth parallel with their shaft, and owing to the special form of the teeth these pumps run silently. From the accumulator the oil passes to the main governor valves or through separate pipes to the hand control. The hand operating gear is located at the servomotors, but two wheels for manipulating the control are located on the governor stand. As is now common practice with large units, the main regulating valves are located on the servomotor.

On the governor the actuator is of Prof. D. Thoma's design and is carried on knife edges. In this, as well as on all standard Thoma governors, all levers and fulcrums are held on their seats by means of springs to prevent lost motion, if any wear should occur. The actuator and compensating mechanism are mechanically connected, there being no elastic or flexible arrangement either hydraulic or otherwise, and thereby the correct action of the governor is obtained under all conditions.

In Fig. 5 the two handwheels *A* and *B* can be used to control the regulating mechanism. Handwheel *A* controls the speed regulation and *B* the gate opening or stroke limiter. By means of the latter the turbine can be started up or closed down without putting in the hand operating gear. These governors have worked satisfactorily in all respects, and the tachogram, Fig. 7, taken at the official tests shows the speed regulation with different values of load change. The speed variations were under the figures guaranteed, notwithstanding that the flywheel effect was less than was called for in the design.

Contract for the turbines included a guarantee that the best efficiency would be obtained at or near full load. Fig. 9 gives the official results of the tests, and the efficiencies obtained exceed those guaranteed even at part loads. The water was measured with current meters. Seventeen of these were used and 13 readings



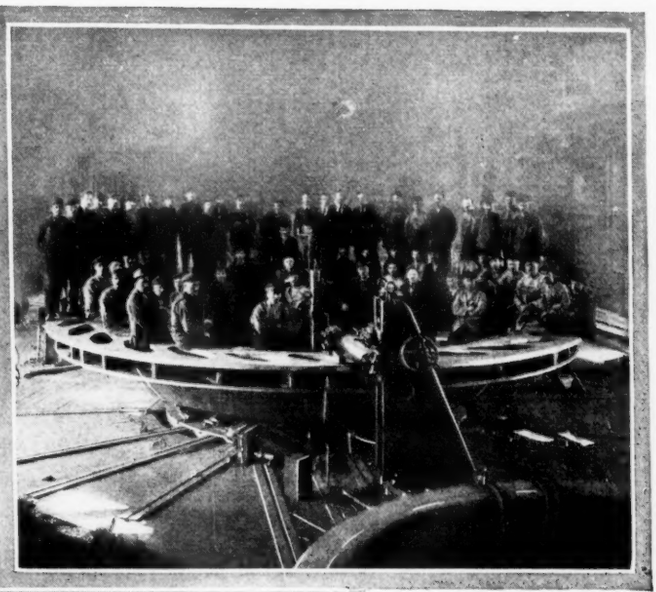


Fig. 2 (Above)—One of the Lawaczeck runners in the shop

This runner is 19 ft. 8 in. diameter and weighs about 50 tons.

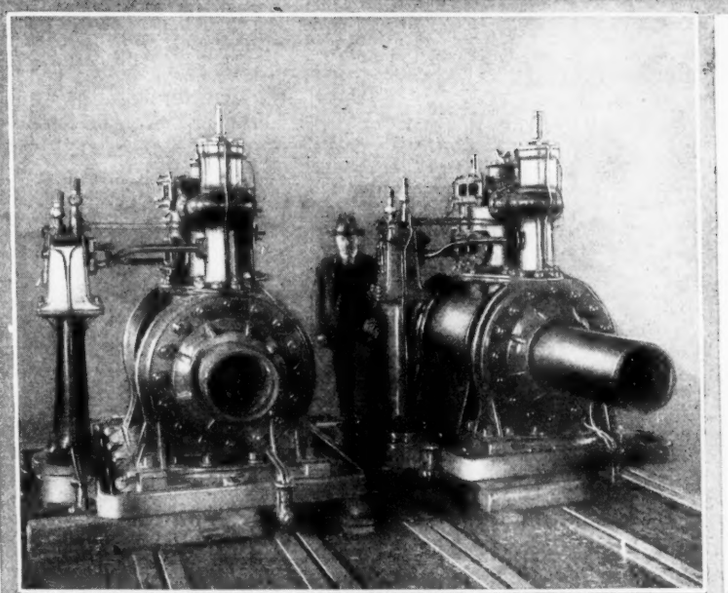


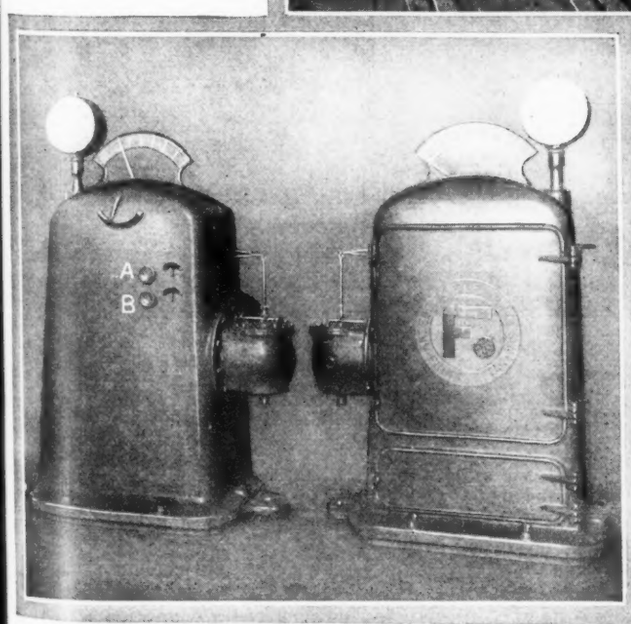
Fig. 3 (Above right)—Crown plate for one runner

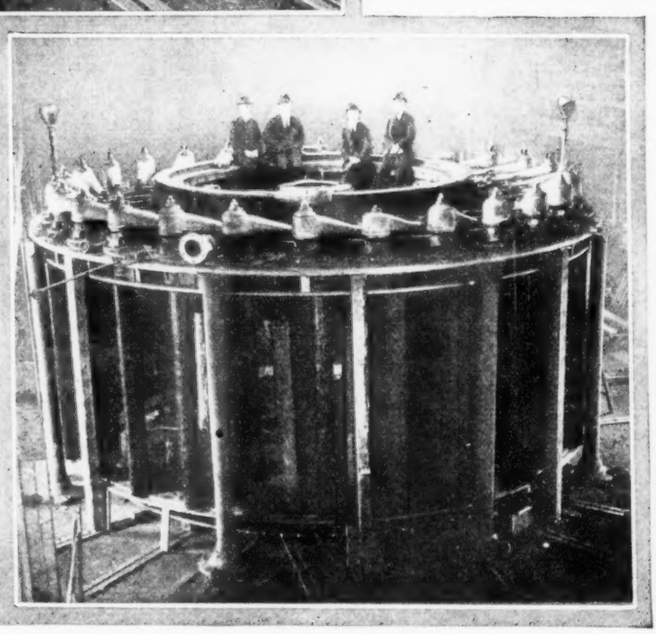
Holes are provided in this plate so that any one of the guide vanes may be removed without disturbing the other parts of the unit.

Fig. 4 (Left)—Servo-motors and control valves for one unit

Fig. 5 (Lower left)—Two views of one governor

Fig. 6 (Below)—Guide-vane structure and crown plate





were taken at each location, making a total of 221 readings. The efficiency between ¾ and full load is the highest, and this is the range where the best efficiency is required.

When the first unit was ordered, the highest efficiency guaranteed was 85 per cent at ¾ load. This was increased to 87 per cent when the second unit was ordered.

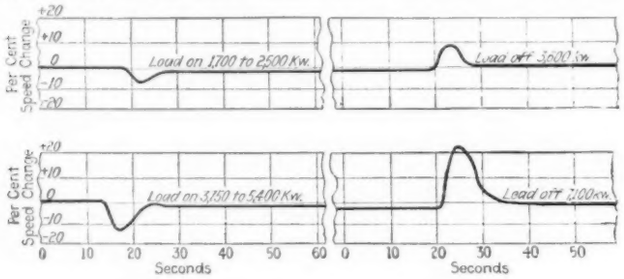


Fig. 7—Records of speed regulation

As can be seen from Fig. 9, the curve obtained gives an efficiency of 93 per cent at near full load. The efficiency of the units is over 90 per cent with outputs above 10,000 hp. It will be seldom that the load on the plant will go below this value; on the contrary it will be necessary to develop as near full output of the station as possible, and the Lawaczeck wheels will then, in full agreement with their purpose, run continuously while the Kaplan turbine will take care of the load required above their capacity. In this way the greatest number of kilowatt-hours will be obtained from the water available.

For plants with two or more units, it should not be a question of Lawaczeck or Kaplan turbines, but of both. For plants with a large number of units the most economical arrangement will be obtained with propeller turbines with fixed vanes. It should be noted that the wheels with fixed blades can be built at lower cost than those with movable blades, and owing to the shorter draft tube required for the former, the building costs are lower.

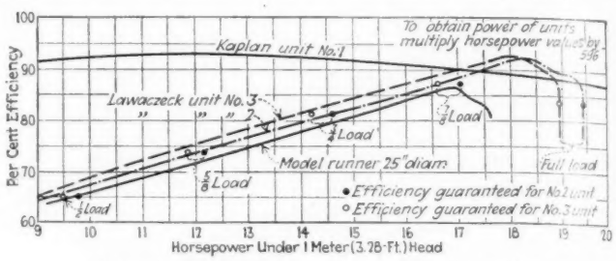


Fig. 9—Efficiency curves of three units

In the development of the Lawaczeck wheels C. A. Svala was the chief designer and had associated with him Dr. Franz Lawaczeck.

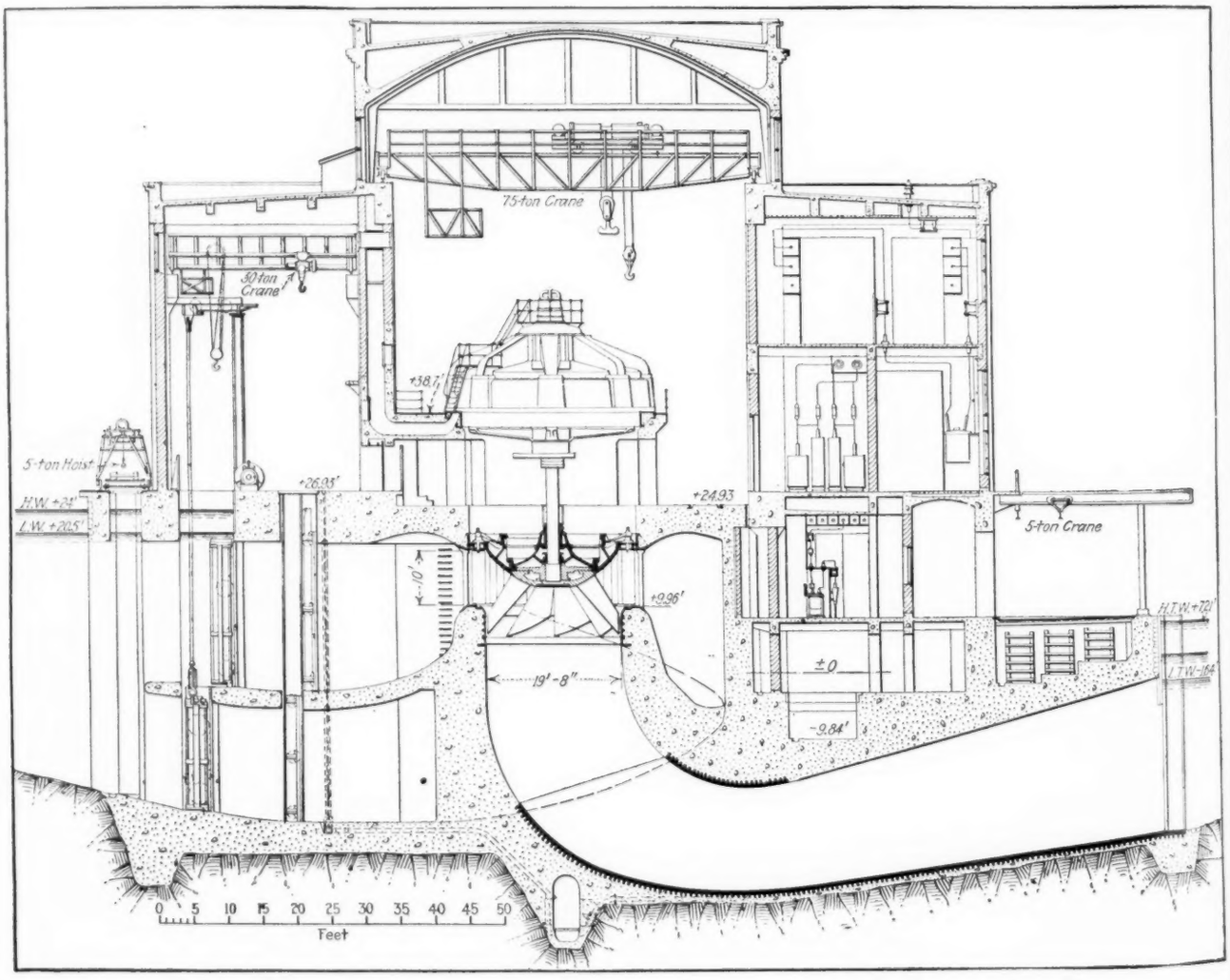


Fig. 8—Section through power house on the center line of one of the Lawaczeck units

High-Pressure Power-Station Design in the Middle West*

By F. S. COLLINGS†

OUTSTANDING points of interest showing why 500 to 600 lb. is the most economical steam pressure for large stations, the gain from reheat and air preheating, including pointers on the choice of fuel-burning equipment, water vs. air-cooled furnaces, evaporators and the relative merits of the closed feed-water system as against the flash system for the deaëration of boiler feed water

IN CONSIDERING the principal factors involved, it is assumed that there is available a suitable site, the necessary railroad facilities, an adequate supply of circulating water for the condensers, fuel, and a source of reasonably good water for boiler-feed makeup. The capacity of each of the units will depend upon existing station load, the anticipated load, load factor, and capacity factor over a period of, say, three years, and the planned ultimate capacity.

The next major question arising is that of steam pressure, and a brief résumé of past history will explain why 500 to 600 lb. has become more or less standard pressure at this time for the larger stations. Toward the end of the year 1922—that is, before the 550-lb. Philo station became an accomplished fact—it fell to the lot of the writer to make a thorough investigation into economies of high-pressure steam as applied to the central station. At the outset it was discovered that there was available neither a steam table nor temperature entropy diagram covering the pressure and temperature field under consideration, so the existing tables were extended to 1,200 lb. abs. and 750-deg. F. total temperature, using the formulations of Prof. H. L. Callendar, and this was the basis on which subsequent calculations were made. The net results of these calculations are shown in the accompanying graphs, Figs. 1 to 6.

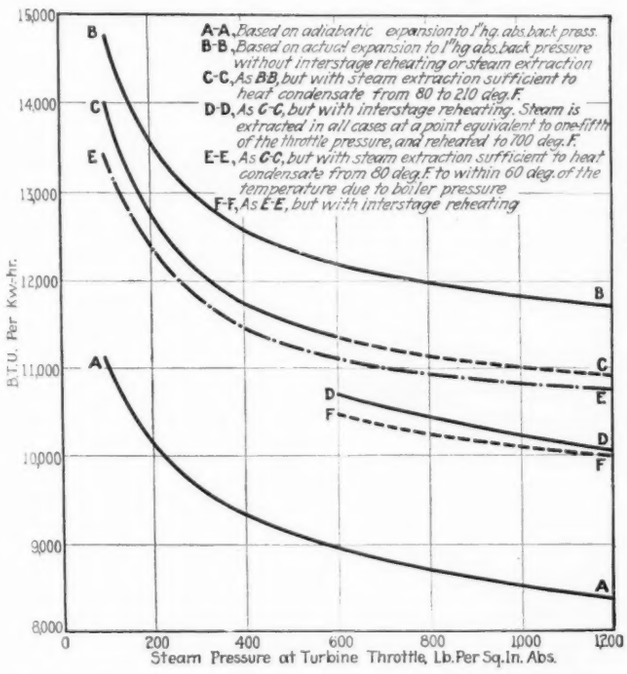

A-A, Based on adiabatic expansion to 1" hg. abs. back press.
B-B, Based on actual expansion to 1" hg abs. back pressure without interstage reheating or steam extraction
C-C, As B-B, but with steam extraction sufficient to heat condensate from 80 to 210 deg. F.
D-D, As C-C, but with interstage reheating. Steam is extracted in all cases at a point equivalent to one-fifth of the throttle pressure, and reheated to 700 deg. F.
E-E, As C-C, but with steam extraction sufficient to heat condensate from 60 deg. F. to within 60 deg. of the temperature due to boiler pressure
F-F, As E-E, but with interstage reheating
B.T.U. Per Kw.-hr.
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
0
200
400
600
800
1000
1200
Steam Pressure at Turbine Throttle, Lb. Per Sq. In. Abs.

Fig. 1—B.t.u. per kw.-hr. to turbine units with different steam pressures and constant total steam temperature of 700 deg. F. at the throttle

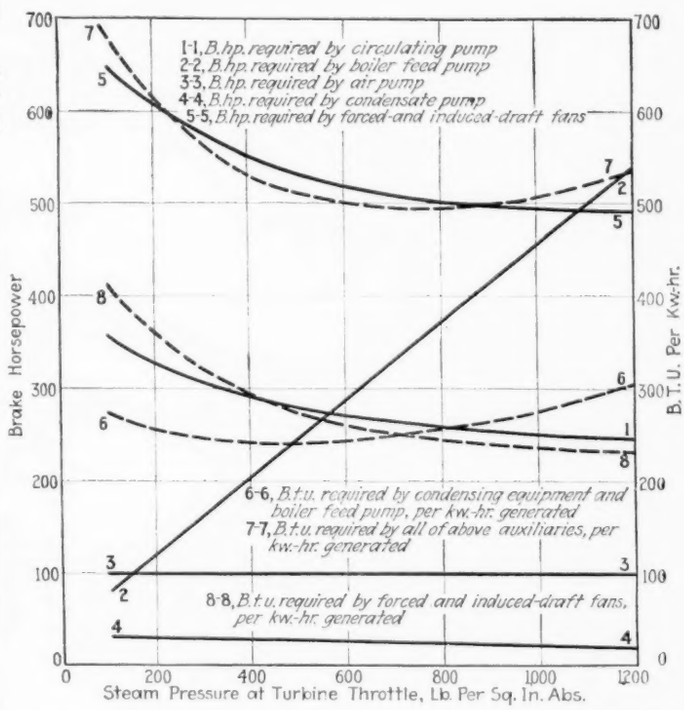


Fig. 2—Power required by motor-driven auxiliaries of 30,000-kw. turbine unit with different steam pressures and constant steam temperature 700 deg. F. at throttle

Turbine is operated in each case with steam extraction sufficient to heat condensate from 80 to 210 deg. F., and with interstage reheat at and above 600 lb. per sq.in. throttle pressure. All as in curves *C-C* and *D-D* on graph 1

In the final analysis in which investment and operating charges are balanced against thermal efficiency, it is apparent that a working pressure of 600 lb. offers the best return on the invested dollar at this time. This is true even of the direct-expansion turbine, while

*Abstract of a written discussion following the paper by V. E. Alden on "Present Tendencies of Steam Station Design," A.S.M.E. regional meeting, Kansas City, April 4-6.

†Mechanical engineer, Sargent & Lundy, Inc., Chicago, Ill.

the additional gain due to reheating at or slightly above that point in the expansion curve which approaches saturation at the normal expected load, is from 4½ to 6 per cent according to the turbine characteristics.

It has been a matter of surprise to the pioneers in the reheat field that the interstage reheater justifies its investment charges over a wide unit-load range. In addition to the greatly increased temperature and

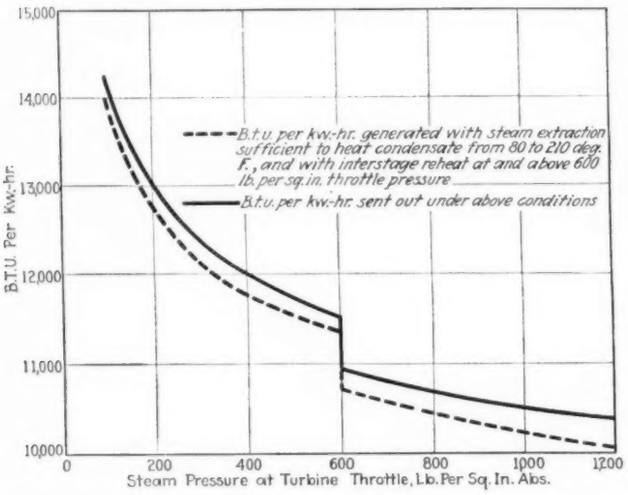


Fig. 3—Performance of 30,000-kw. turbine unit with different steam pressures and constant steam temperature of 700 deg. F. at the throttle

total heat head at the inlet to the low-pressure cylinder, reheating transfers the drip point from what would be a relatively high stage at fractional load to approximately the last wheel, which fact contributes in no small degree to low turbine depreciation as well as to increased stage efficiency.

Temperature of the Air for Combustion

That the regenerative cycle will be used for feed-water heating may be taken as a matter of course, but in considering the steam-extraction characteristics of the main unit, the obvious question is, At what temperature may the air for combustion be admitted to the stoker or the pulverized-fuel equipment, as the case may be? If it is to be limited to, say 300 deg. F., to avoid undue strain and deterioration in a chain grate, then a water economizer followed by a relatively small air preheater is indicated. In such a case it is advisable to limit the regenerative feed-water heating to a value that will insure an adequate return from the economizers. As an alternative, the gas-heated water economizer may be omitted, an air heater of sufficient surface to reduce the boiler outlet gas temperature to the desired stack temperature installed, and a fin-tube air cooler placed in the air outlet duct from the air heater to temper the air to the stoker requirements.

This air cooler uses boiler-feed water at a fairly low temperature point in the cycle as a circulating medium and, when arranged with a suitable bypass, affords a convenient and flexible method of regulating the temperature of the air to the stoker. This arrangement also has the advantage that the air-cooler surfaces are always clean, which is not the case with the flue-gas heated economizer, and it escapes the corrosion due to the precipitation of acid soot, which occurs in the latter when on bank or whenever the tubes are chilled below the dew point either by low feed-water temperatures or by operating at low ratings.

If, on the other hand, pulverized fuel is to be used, the secondary air at least may be preheated to the limit established by the gas-outlet temperature from the boiler, qualified by the economic restriction which imposes a reasonable terminal difference. In this event the feed water may be heated by steam extraction from the main turbine to within, say, 50 to 100 deg. F. of the boiling point due to the pressure. In this connection it should be noted that the reheat turbine lends itself particularly well to this latter cycle, for the reason that steam is available at the high-pressure cylinder exhaust at a pressure high enough to correspond to a temperature of from 300 to 400 deg. F. in the average case, while at the same time it is at or even below saturation, according to the load.

Choice Between Chain Grate and Underfeed Stokers

Relative to the use of chain grates, underfeed stokers or pulverized fuel, the writer's views on this subject were expressed in a paper[1] read before the Midwest Power Conference in Chicago in February of this year. As to the decision between the chain grate and the underfeed stoker, it has been found desirable to use the latter when a low-ash coking coal is to be used, as at the West End station in Cincinnati and at the Pineville plant of the Kentucky Utilities Company. In the case of the high-ash and free-burning bituminous coals of

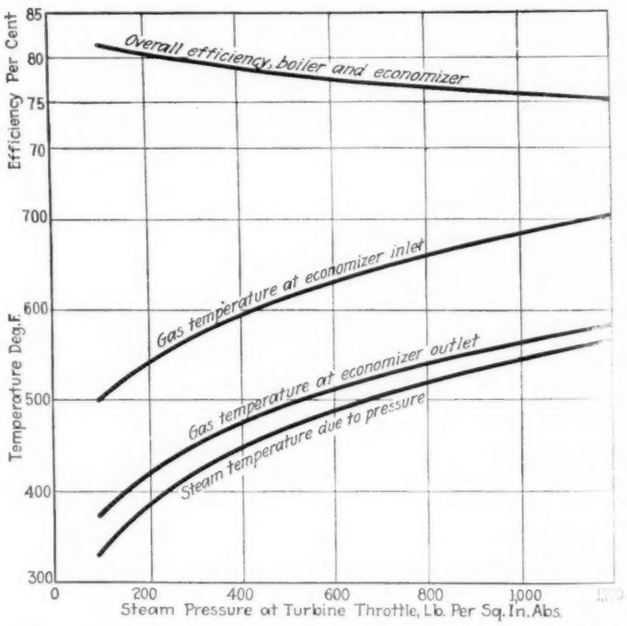


Fig. 4—Calculated performance of "Calumet" type boiler, having economizer surface sufficient to raise feed-water temperature within 60 deg. F. of the temperature due to pressure

Illinois the forced-draft chain-grate stoker is being used, as in the stations of the Commonwealth Edison Company, the Public Service Company of Northern Illinois, and others.

At the Columbia Power Station, just outside of Cincinnati, the storage system of burning coal in pulverized form is in use, as it is also in connection with one ex-

[1] See *Power*, March 29, 1927, pp. 476-79.

perimental boiler at the new Calumet Station in Chicago.

The unit system of pulverized-coal burning has been installed at Sheboygan, Wis., and is contemplated for some other plants in Texas and Oklahoma, where in all probability it will handle either lignite or the subbituminous coal from the north central district of Texas.

In boiler installations where continuously high evaporative rates are expected, with one notable exception the furnaces are being water cooled either partly or wholly, according to the furnace design, the nature of the fuel and the form in which it is to be burned, and inasmuch as a great deal remains to be learned in the application of the water-cooling surface to the furnace, these installations are being made comparative as far as possible.

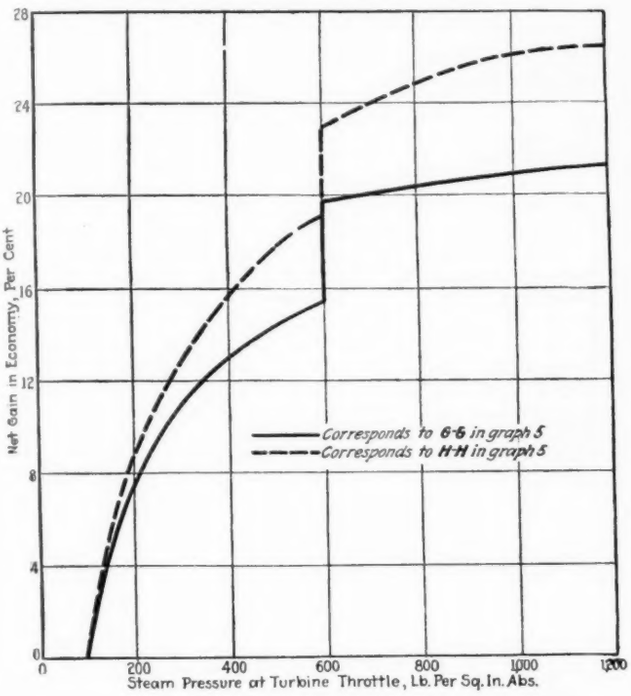

Net Gain in Economy, Per Cent
Steam Pressure at Turbine Throttle, Lb. Per Sq. In. Abs.
Corresponds to G-G in graph 5
Corresponds to H-H in graph 5

Fig. 5—B.t.u. per kw.-hr. to turbine units with different steam pressures and constant steam temperature of 700 deg. F. at the throttle.

Turbine is operated in each case with steam extraction sufficient to heat condensate from 80 deg. F. to within 60 deg. F. of the temperature due to pressure, and interstage reheat at and above 600 lb. per sq.in. Steam is supplied by "Calumet" type boilers having economizer surface sufficient to raise feed temperature 60 deg. F. to steaming point

The exception referred to is the Columbia Station of the Columbia Power Company, near Cincinnati. This plant, which is burning West Virginia coal in pulverized form, is equipped with air-cooled furnaces. The boilers are operated at an average output corresponding to between 250 and 265 per cent of rating, and during the two years that have elapsed since the plant was started, the furnace maintenance has been negligible.

It must be borne in mind, however, that the problems involved when burning Logan County coal are entirely different from those encountered when Illinois coal is to be used. Thus at Crawford Avenue Station there are refractory furnaces, furnaces with bridge-wall and side-wall water-boxes, furnaces with water-cooled side walls and furnaces entirely water cooled. There are bare-tube surfaces with tubes on various centers and walls with refractory-faced and bare iron blocks.

This use of radiant heat surface in the furnace emphasizes a factor that the use of high pressures already had brought to the front, which is the evaporator for boiler-feed makeup. The multiple-effect, low-heat-level evaporator has been in use for a number of years at Tulsa, Oklahoma, Philo, Twin Branch and elsewhere, and has long since justified its installation when either bad water, high steam pressure or a combination of the two, are concerned. Recently, however, the tendency has been to install the evaporator in unit form rather than as a central water-treating plant.

In other words, a single- or double-effect evaporator is being made an integral part of the regenerative feed-water system of each main unit, to the needs of which it lends itself admirably. It is flexible as to heat level and pressure range, it utilizes extracted steam as a heating agent, and the applied heat may be recovered except for the heat in the blowdown and that lost by radiation. In addition, it is a low-priced piece of apparatus requiring no additional pumps except for re-circulation, and no special condenser, as the vapor from the last effect is used to supplement extracted steam in one of the low-pressure stage heaters. This heater requires no additional surface, as the evaporator should be run off-peak as far as practicable, under which condition extraction pressure and flow are below normal.

For generator air cooling the closed system with external fans and single-stage or two-stage water cooling, has become standard at this time. In the single-stage air cooler the water is taken either from service wells or from the main condenser circulating water system. In the two-stage cooler there are two sections of water-cooling surface, the higher-temperature section taking condensate from the main unit hotwell pumps, and the low-temperature section using either ground water or water from the main condenser cir-

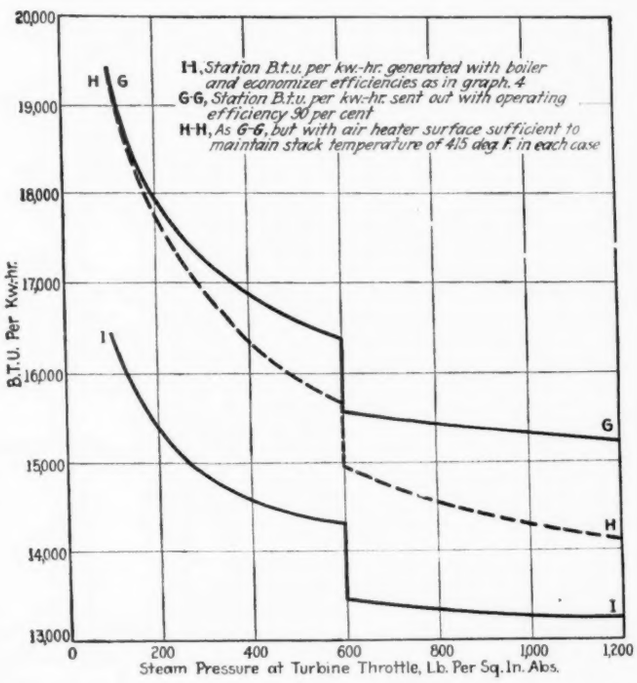

H, Station B.t.u. per kw-hr. generated with boiler and economizer efficiencies as in graph. 4
G-G, Station B.t.u. per kw-hr. sent out with operating efficiency 90 per cent
H-H, As G-G, but with air heater surface sufficient to maintain stack temperature of 415 deg. F. in each case
B.T.U. Per Kw-hr.
Steam Pressure at Turbine Throttle, Lb. Per Sq. In. Abs.

Fig. 6—Net gain in economy at different steam pressures and constant total steam temperature of 700 deg. F. expressed as percentage over results obtained at 100 lb. per sq.in. abs. and 700 deg. F.

culating system. This latter system is more expensive and involves more piping than the former, while the heat recovered by the turbine condensate reduces the low-pressure extraction by a corresponding amount, and therefore does not present any improvement in economy.

With regard to deaëration, there is considerable difference of opinion on the part of operating engineers as to the relative merits of the closed feed-water system and of the flash system. The former requires closer attention to the physical condition of the plant than does the latter. To insure the exclusion of soluble gases from the closed system, all main condensers must be free from circulating water leakage through split tubes or leaking ferrule packings, all closed heaters and connections which operate at pressures below atmospheric must be tight, hotwell pumps must be of the double-impeller central-inlet type having the glands under internal pressure instead of vacuum; emergency cold feed connections to the suction of the boiler-feed pumps should be double valved, and so forth.

The flash system of deaëration, in which the separator is the last step in the feed-water system before the boiler feed pump, allows more margin in the physical condition of the plant. It is not intended to suggest that neglect is allowable, but to point out that the system can continue to supply air-free water to the boiler plant even should a joint fail in a low-pressure heater steam connection or a condenser tube split at a time when it is not practicable to shut down the unit.

On the other hand, the flash system requires a definite temperature relation between the water outlet of the vapor condenser and the discharge of the final heater to the separator. A variation of five degrees in a terminal difference of twenty-five is allowable under normal load conditions, but not more; and it must be recognized that with the flash system, fairly close attention must be given to the temperature relations maintained throughout the deaërator system. This is particularly true on fluctuating loads.

Both of these systems are in use at the Crawford Avenue Station in Chicago, and the results indicate that they are equally satisfactory when given the necessary attention.

With regard to coal and ash handling, each plant presents its individual problems which are almost entirely the result of purely local conditions such as the source of fuel, whether it is the intention to buy at prevailing prices and so limit the amount of storage to a minimum or to provide storage space enough so that the operating company may avail itself of favorable market conditions. Again, whether the nature of the coal will allow of storing to a considerable height, whether it must be laid down in shallow piles and vented, whether it must be kept moving or even, perhaps, placed in submerged storage.

As It Is Impossible To Prevent Superheating in the cylinder of an ammonia compressor, the only thing to do is to keep the superheat as low as possible. Have the ammonia reach the compressor as nearly saturated as permissible with the type of machine and the operating conditions. A thermometer inserted in the suction line close to the compressor should show a temperature not over 5 deg. above that corresponding to the suction pressure. In many vertical compressors the jacket water heats up the ammonia vapor. This can be avoided by filling the bottom of the jacket with cork and cement.

What Do You Know?

ANSWERING the list of questions below will be found to do wonders in refreshing your memory of many general engineering facts, some of which may have almost been forgotten. Frankly, the member of the editorial staff who works up these tests, finds at times that he cannot answer his own questions without considerable thought.

If you feel that the answers on page 891 are wrong, do not hesitate to write the editor about his error.

Ques. 1—If the load is light, should the ashpit doors of a hand-fired boiler be closed?

Ques. 2—What is the relative necessary thickness of the head and girth sheets of a 72-in. by 18-ft. boiler?

Ques. 3—Why do some duplex steam pumps have two ports at each end of the cylinder?

Ques. 4—What are two systems of pulverized coal now in general use, and what are the features of each system?

Ques. 5—When the weak liquor absorbs ammonia gas in the absorber of an absorption system, will it become warmer or cooler?

Ques. 6—What is the heat value of anthracite?

Ques. 7—Is more air required to burn a fuel high in hydrogen than a low-hydrogen fuel?

Ques. 8—If a standpipe is 10 ft. diameter by 100 ft. high, will it exert more pressure in pounds per square inch on the street main than a standpipe 3 ft. diameter of the same height?

Ques. 9—Will a lubricating oil evaporate upon being heated?

Ques. 10—What firm built the first American engine burning fuel oil in the cylinder?

Some Interesting Experiments on Athletes have been conducted by Prof. A. V. Hill at Cornell University. The initial results of his experiments show that the human body, while running, works at about 40 per cent efficiency; that is, the total amount of energy expended is about 2½ times the amount of work actually accomplished. This is a creditable showing for the human machine and is some 10 per cent higher than is now obtained in Diesel-engine practice.

Alternating-Current Elevator Controllers—
How Single-Speed Full-Magnet Types Operate

By CHARLES A. ARMSTRONG

THREE control arrangements are considered for use with single-speed squirrel-cage motors. Two of these are for connecting the motor directly to the line, and one uses one step of starting resistance.

ELEVATORS with hand-rope control are rapidly being superseded by those having a full-magnet type—that is, car-switch or push-button control —or a combination of the two—dual control. Safety codes, local regulations and insurance rates have had much to do with this transition. Where hand-rope control is limited to car speeds of about 100 ft. per min. or less, full-magnet control is applicable to any car speed. With single-speed control 200 ft. per min. is about the limit of car speed, on account of the difficulty in making good landings. Although in some cases single-speed control has been used for considerably higher speeds, good practice would dictate 200 ft. per min. or less. For medium-speed elevators multi-speed motors are required in alternating-current elevator service, to provide the necessary slow down. With single-speed motors of either the squirrel-cage or the slip-ring type no slow-down action or dynamic braking effect can be obtained and the car must be stopped from full speed with the mechanical brake. This, therefore, limits single-speed motors to slow-speed service.

Single-Speed Squirrel-Cage Motor

A single-speed high-torque squirrel-cage motor with full-magnet control is limited in application to car speeds at which smooth acceleration and stopping can be obtained. Up to 100 ft. per min. smooth acceleration can generally be obtained when the motor is connected directly across the line and good stopping can be obtained with the ordinary type of brake. At higher car speeds one or more steps of starting resistance are necessary for smooth starting and acceleration, while smooth stopping depends upon the brake pressure being gradually applied. This brake action is most commonly obtained by the use of a dashpot to retard the brake's application.

In Fig. 1 is shown a Westinghouse controller for starting a squirrel-cage motor by connecting it directly to the line, and Fig. 2 is the wiring diagram for this controller when applied to a traction-type elevator. The relays P and P_1 give phase-failure and reverse-phase protection to the motor.

On relay P_1 the coil is connected directly across the line from L_3 on potential switch C to L_1 on the up-direction switch U. Energizing this coil causes the contact of relay P_1 to close and complete a circuit for coil P from L_3 through inductance X, contact P_1 and coil P to L_2 line. Making this circuit alive causes the contact of relay P to close. A second circuit is formed through inductance X which includes resistances R and R_1 to the L_1 side of the line. The combined effect of the two circuits through inductance X is to cause relay P to open in case of a reverse phase.

If either line L_3 or L_1 opens, relay P_1 will open and interrupt the circuit to coil P and this relay will also open, so that the controller cannot be operated from the car switch. An open in line L_2 will cause relay P to

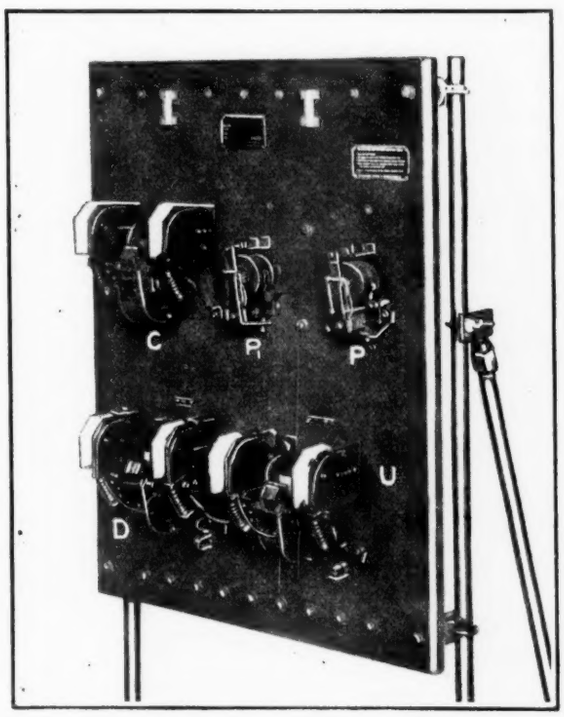


Fig. 1—Controller for connecting a squirrel-cage motor directly to the line

U and *D*, direction contactors; *C*, line contactor; *P* and P_1, reverse- and open-phase relays.

open, and as the contact of this relay is in the car switch circuit, the controller cannot function with this contact open.

Assume that the relay contacts P and P_1 are closed, then there is a circuit completed to the car switch from L_1, through contact P, fuse F, the door contacts and returns to O on the controller and to the common connection on the car switch. With the car switch thrown to the down position, contacts $2D$, $3D$ and $4D$ close and a circuit is completed through $2D$, the down limit switch to *21* on the controller. The circuit then continues through the coil of down-direction switch D, auxiliary contacts U_1 on up-direction switch U, through the slack-cable switch, the gate contact, car-safety switch, over-travel limits, governor switch and returns to the

controller, then through fuse F_1 and to the L_3 line. Completing this circuit causes coil D to close its contactor.

When closing, contactor D opens its auxiliary contacts D' and closes D''. The closing of auxiliary contacts D'' completes the circuits for the coil of potential switch C, from O terminal at the top of the panel, through coil C, auxiliary contact D'' to terminal 70 and to L_2 line as previously explained. Completing this circuit causes contactor C to close and with direction switch D completes the circuits to the motor.

At one instant, the motor circuits will be from L_2 line, through the left-hand contact of potential switch C to T_2 on the motor. After including the motor windings, the circuits return to T_1 and T_2 on the controller, then from T_1 through the right-hand side of the direction switch D to line L_2. From terminal T_2 the circuit is through the right-hand side of potential switch C and the left-hand side of direction switch D to line L_1. This connects the motor directly to the line. The brake coils are connected to the motor terminals, therefore are energized with the motor and release the brake and the motor starts and comes up to speed.

For up direction, the circuits are the same as already explained, except that coil U is energized instead of D, and when contactor U closes, it reverses leads T_1 and T_2 to the motor and causes it to run in a reverse direction.

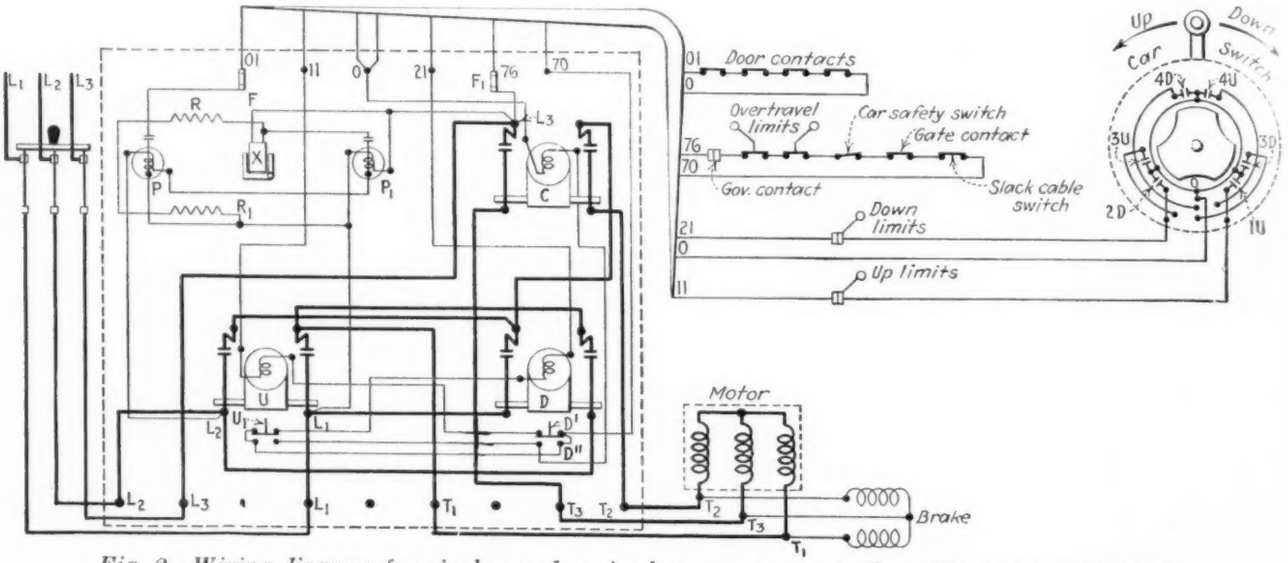


Fig. 2—Wiring diagram for single-speed squirrel-cage motor controller with electrical interlocks on direction switches

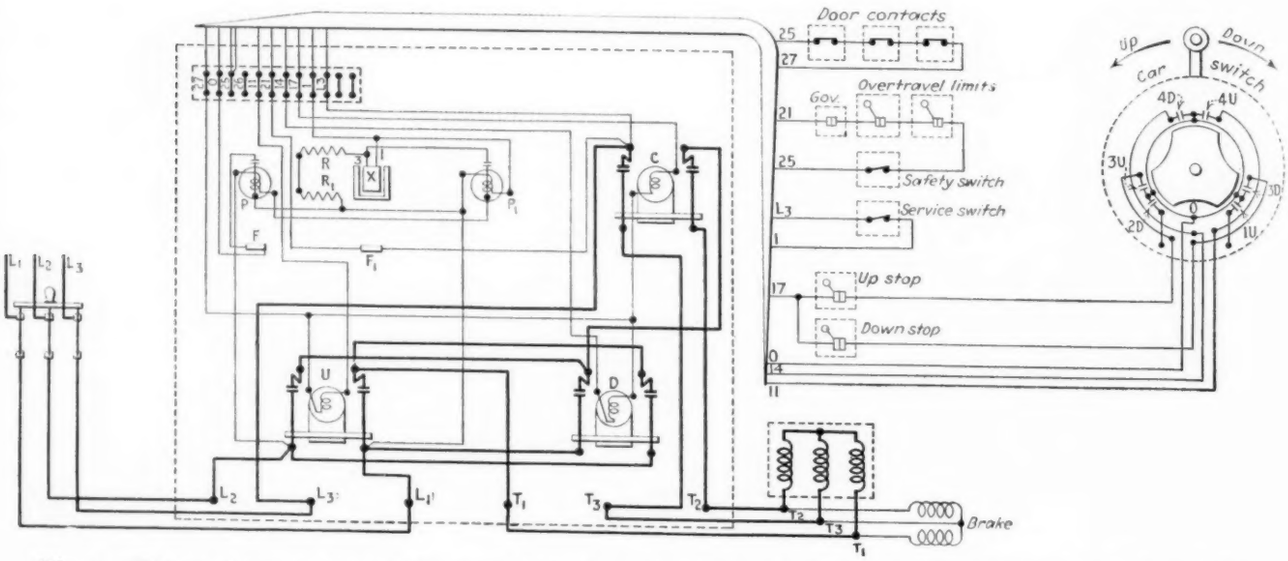


Fig. 3—Wiring diagram for single-speed squirrel-cage motor controller with the line and direction switches controlled through the car switch

On the car switch with the hookup, Fig. 2, only two of the six contacts are used, the other contact being used for other arrangement of connections. Fig. 3 shows the connections for controlling the potential switch through contacts on the car switch instead of auxiliary contacts on the direction switches D and U, as in Fig. 2. The phase-relay connections are the same in both diagrams, except that in Fig. 3 a service switch is connected in series with the coil of relay P_1. The circuit for this coil is from L_1 line through the coil to

terminal 1 at the top of the panel, then through the service switch and back to line L_3 on the controller. This switch may be located in the car and provides a means of disconnecting the phase relays from the line when the elevator is not in service and saves the power that would otherwise be expended in these coils.

When the car switch is closed to either the down or up position, a circuit is made for one of the direction switch coils D or U and another for the potential switch C. Assume that the car switch is in the down position, then a circuit is completed from line L_1 through the contact of relay P, fuse F to the common connection O on the car switch. Contacts $3D$ and $4D$ will be closed with this switch in the down position. Then, from O on the car switch, one circuit is through contact $3D$, the down limit switch to 17 on the controller and through the coil of potential switch C, through the door contacts and return to terminal 25 on the control panel, then through the safety, overtravel-limit and governor switches to 21 terminal on the controller and to L_3 line.

From $4D$ on the car switch, a circuit is made to terminal 14 on the controllers through the coil of direction switch D and then through the limit switches to line L_3 as explained for potential-switch coil C. Making

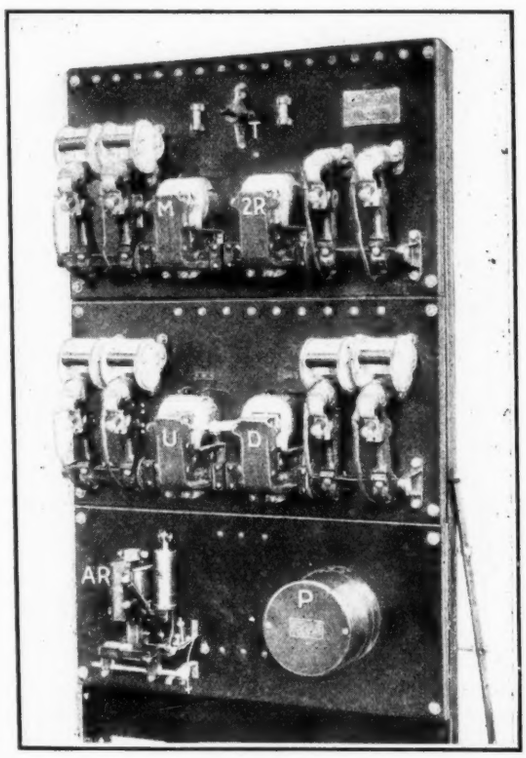


Fig. 4—Controller for starting squirrel-cage motor through one step of resistance

U and *D*, direction contactors; *M*, line contactor; *2R*, accelerating contactor; *AR*, timing relay for accelerating contactor; *P*, reverse- and open-phase relay; and *T*, test switch for operating the car at the controller.

these circuits alive causes switches C and D to close and apply power to the motor and brake, as explained for Fig. 2.

It is not an uncommon practice of elevator operators, when door contacts are used, to pull the car switch to the on position and then close the landing door to start the car. This puts a service on these contacts that they are not designed for and is a source of trouble as well as a certain element of danger. This practice can be prevented by using sequence relays. With these relays if the car switch is moved to either on position before the landing door is closed, the control magnets cannot be energized until the car switch is moved to the off position, the door closed and then the car switch moved to the on position.

To provide smooth starting of the elevator and to keep down the inrush current at starting, one section of

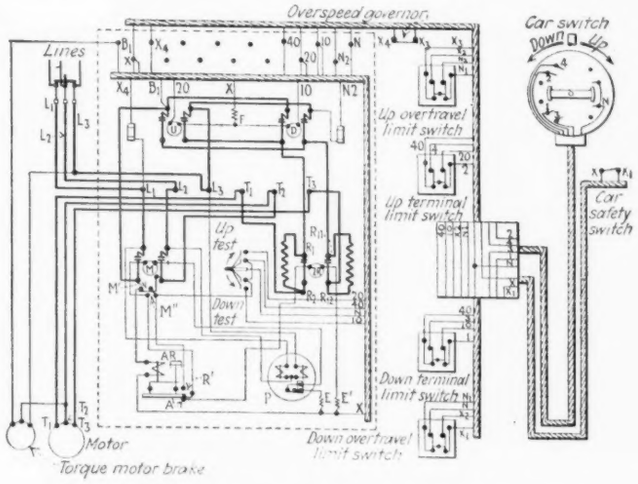


Fig. 5—Wiring diagram of the controller Fig. 4

resistance may be connected in series with the stator winding of the motors, on slow-speed elevators. On high-speed elevators the starting resistance is generally cut out in several steps. Fig. 4 is the front view of a Cutler-Hammer controller for starting a squirrel-cage motor through one step of resistance, and Fig. 5 is a wiring diagram of this type of controller for a traction machine. The car switch on the wiring diagram has three points for each direction. On some controllers this would indicate that the controller was arranged for two speeds. However, in this case there is only one speed, one point on the car switch in each position being from the direction switch and the other for the potential switch.

Phase-Failure Relay

On the phase-reversal relay P the two coils are connected directly to the three lines, L_1, L_2 and L_3. As long as the power conditions are correct, the contact on this relay will remain closed and complete the circuit for the potential-switch coil M. Assume that the car switch is moved to the down position. In this position contacts N, 3 and 1 will be connected together. Closing of the car-switch contacts completes a circuit for the potential-switch coil from the L_3 line up to N_2 at the top of the controller, then through the up-overtravel hoistway limit switch, to N_1 on the down-overtravel hoistway limit switch and to the junction box in the hoistway. In the hoistway terminal box line N branches, one branch going to the center of the test switch on the controller and the other to the center of the car switch. So far the control circuit is common to both the potential switch and the up- and down-direction switches.

Starting at the car-control switch with it in the down position, a circuit is provided from 3 on this switch through the down terminal limit switch to 40 on the controller. From terminal 40 the circuit goes to the test switch and to auxiliary contact M' on potential switch M, through the coil of timing relay AR to ter-

minal X at the top of the panel. From X at the top of the panel, the circuit is through the safety switch in the car, overtravel limit switches, the governor switch, and returns to X_1 at the top of the controller and goes to the L_1 side of the line. Energizing this circuit causes the timing relay AR to pull up its core and, in doing so, opens contact A' and closes contact R'. This operation opens the circuit to coil $2R$ and prevents it from closing its contacts and short-circuiting the resistance in the stator circuit of the motor. Closing contact R' completes a circuit for coil M of the line contactor, from 40 through contact R', coil M, contacts of phase relay P, resistance E, to X and to the L_1 side of the line, as previously explained. Making coil M alive causes it to close its contactor.

From 1 on the car switch a circuit is completed for the down-direction switch through the down terminal limit switch, to 10 at the top of the control panel. One branch from 10 goes to 10 on the test switch, and the other through coil D and resistance F to X and to the L_1 side of the line, as previously traced through. With the circuit through coil D alive, its contacts are closed, and this operation in conjunction with contactor M closing completes the circuits to the motor. These circuits may be traced from line L_2 through the right-hand contact of switch M to T_2 on the motor, through the motor windings to T_1 and T_3 terminals on the controller. From T_1 the circuit continues through resistance R_2R_{11}, the left-hand side of direction switch D and of line switch M to the L_1 side of the line. From T_3 another circuit goes through resistance $R_{12}R_{11}$, the right-hand side of direction switch D to the L_1 side of the line.

Operation of the Brake Torque Motor

The three leads from the brake torque motor are energized with the closing of the potential switch. This releases the brake, and the motor starts with the resistance in series with the stator winding. Where a magnet is used to release the brake, its coil is connected directly to the motor terminals. Where a torque motor is used, as in the figure, it must be connected outside the direction switches or it would be reversed with the motor and would not release the brake in one direction.

When contactor M closed, it opened auxiliary contacts M' and closed M''. Opening contacts M' interrupts the circuit through the coil of timing relay AR, and this relay begins to open, but is retarded by a dashpot. Closing contacts M'' completes a circuit from coil M, without going through contact R' on the timing relays so that contactor M remains closed when contact R' opens. When the timing relay opens, it closes contact A' and completes a circuit through coil $2R$. This circuit is also through contacts M'' on contactor M, then through contact A' on the timing relay, coil $2R$, resistance E' to X, through the safety devices as previously explained to the L_1 line. Energizing coil $2R$ causes it to close its contacts and short-circuit resistances R_1R_2 and $R_{11}R_{12}$ out of the stator circuit and the motor comes up to full speed.

On up direction, the same series of events takes place, except direction switch U closes instead of D. The test switch on the controller allows operating the elevator from the control panel without going on the car, when locating trouble or when testing the equipment.

With the car in the down motion, on approaching the bottom landing, the terminal limit switch is opened by the car. Opening of this switch performs the same functions as centering the car switch and the car should stop. If the car goes a short distance below the floor, it will open the overtravel limit switch, which will open the common circuit N to the car switch and the common return circuit from the controller contactor coils. When the car runs on the overtravel limits, the machine cannot be started until the car has been raised enough for this switch to close. This generally can be done by releasing the brake and moving the car by hand. On the up motion this is not so easily done by hand, as the car has to be moved down and the counterweights raised. As the counterweights generally equal the weight of the car plus 40 per cent of the rated load, they are heavy to raise unless overbalanced by a load in the car. Contactor M and the proper direction switch can be held closed by hand and the car moved to the floor by the motor. When doing this, care must be exercised to close the direction switch that will cause the car to move in the right direction. This is particularly true of a drum-type machine, or the car or counterweights may be jammed into the overhead work and serious damage done to the equipment. If the car or counterweights land with a drum-type machine, the cables should be inspected to see that they are in the proper grooves on the drum and sheaves before attempting to move the car, and also see that the cables are not slack.

Preventing Side Wear on Carbon Brushes

For good operation of carbon brushes on electrical machines, they should make a good fit in their holders, yet not be so tight as to prevent free radial movement. Under certain conditions side wear of the brushes is likely to occur and this will not only cause them to become loose in the holders, but also result in a poor fit on the commutator. This side wear is due in general to two causes:

First, actual wearing of the brush due to movement in the holder. Where the commutator is considerably out of round and abrasive dusts are present, the side wear may be quite rapid. This may also occur in certain types of inclosed forced-ventilated motors if the cooling air contains abrasive dust and is blown over the commutator. In this case the wear can be kept to a minimum by maintaining the commutator in a true circle so that the radial movement of the brushes in the holders is negligible.

Secondly, lack of shunt (pigtail) connections between the brushes and holders may also cause side wear. In many cases brushes have operated satisfactorily without shunts. Tests have shown that there appears to be little difference in side wear on brushes with or without shunts. This may be true where the side wear is due entirely to abrasive action between the brush and holder. Where a commutator happens to get into poor condition and the movement of the brush is such as to cause arcing between it and the inside of the holder, if a shunt will prevent the arcing, it will also prevent side wear. In some severe cases of side wear on brushes without shunts the arcing has been bad enough, between the brush and the holder, to pit badly the metal parts of the holder in contact with the brush. This condition tends to aggravate the trouble, and the cause should be eliminated by using substantial shunts between the brushes and holders.

They Started Together as Oilers

By H. M. FRIEND

AFTER working thirty-three years in the same plant, one man is still an oiler, while the other is chief operating engineer.

THAT many engineers are dissatisfied with the opportunities for getting ahead in their line of work is very evident. On almost any job when a group of engineers are together at the noon hour, just ask this question: "Would you follow engineering if you were starting life over again?" From their discussion even an outsider would see that many engineers are discouraged.

This is also reflected in the engineering magazines. Look over the sections, "Letters from Our Readers." As an example, the titles of some of these letters which have recently appeared are: "The Derelict Engineer;" "Middle Age and Opportunity;" "Engineering Failures."

An Antidote for Hard-Luck Stories

If you get into this frame of mind, there is something the matter with yourself or with your job. And the problem is how to better the condition. Perhaps the following story will make you think and give you inspiration. This is an actual life story; for obvious reasons the names and places are fictitious.

While on a construction job in one of the largest generating stations along the Atlantic Seaboard, I had a desk in the office of the chief operating engineer, Luke Jackson.

One day the office boy remarked, "Mr. Jackson, the chief, has been right here in this power house thirty-three years."

Thirty-three years with one company, and especially in the same power station, is a mighty long time, I thought. And I at once became interested, and called on the boy for further information.

"That must be a record for the company," I said.

"No, it ain't," he answered. "Did you ever notice the old gray-haired man, Fred Jones, who cleans up the floor of the Turbine Hall? They both started here the same year, and both on the same jobs, working together as oilers."

The story of these two lives struck my imagination. Here was a remarkable example of two men with an equal start and the same environment. The career of one was development and success; of the other, stagnation and a stationary life.

What were the causes that made the two lives reach such different elevations, I mused, one traveling the road that led toward the top of the hill, while the other trudged the valley road all those years? Was it a case of favoritism or pull in the one case? Or was it a matter of effort and growth in the case of the man who went to the top?

So when Mr. Jackson stepped briskly into his office, I seized the first opportunity and said: "I was interested to hear something about your life, Mr. Jackson. How you started here as an oiler thirty-three years ago, and on the same job with that old man who is still out there on the floor of the turbine hall. I think yours a remarkable case."

His keen gray eyes lighted up, and there was a smile on his ruddy face as he turned to me.

"Yes, I have been here quite a while," he replied. "I started with this company in December, 1893, and have been in this one power house ever since, but there has been nothing unusual in my career. Every day in the week you meet chiefs who started as oilers or ash handlers."

He looked a man of forty-five, at his desk there—though I knew he was really fifty-eight. A kindly, likeable man, with a pleasant word for everybody. One could easily see that he had spent a happy life. With considerable energy and an active step, with rather small angular features, and a strongly pronounced rural accent, I should have placed him as a successful, educated farmer rather than an engineer. Yet when he talked on technical things you could easily see where his heart was.

I had noticed that he was very modest. It was hard to get him to talk about himself. So I tried his favorite subject.

He Worked in the Old Mill

"Did you know anything about electricity before you came here?" I ventured.

"Not the slightest," he answered. "My family lived in a small mill town—no electric drive in those days. The mills were all located on streams and were run by waterwheels. Our family was a large one and we were very poor. I started in the mill with only a few years of schooling. I worked in that mill for ten years till I was twenty-five. For those days I was getting a pretty good wage rate and my family thought I was doing quite well, but I couldn't see anything ahead for me at the mill.

Then times got bad and they would close down for a day or so every week. I began to figure that a steady job at a lower rate of pay would bring in more money;

and the family needed all I could make. So during one of the periods of shutdown I looked around for a steadier job.

"In Norfolk, this city, which is only twenty-five miles away from my home, there was a central station which supplied the town with electricity. They never seemed to shut down, but ran all the time, night and day, and even Sunday. So I got a friend who knew the foreman there to try to get me a job, and, if possible, something to do with the electrical machinery. Well, I got a job as oiler. It was right in this power house. True, you would never know it was the same station. The ground on which it stands is the only thing that hasn't changed. Those totally inclosed turbine-generators of large output you see out there in the turbine hall are not so impressive as the big reciprocating engines that so astonished the boys of those days.

Starting Upward with Determination

"Yes, Fred Jones was an oiler, too, when I started. Both of us celebrated our thirty-third anniversary with the company last December. That first year we often talked together about how to get ahead. The thing that impressed me was the little I knew about electricity. And I determined to learn something, whatever it might cost me in hard work.

"They had night courses in the Y.M.C.A. in Norfolk, and I started one on how to read blueprints. One night on leaving the Y.M.C.A. class I passed the superintendent of this plant. He stopped me and inquired what I was doing there. He was always interested in his men. I told him about the course, but he didn't say much.

"Well, I finished that course and had heard about the correspondence school courses, so decided to take one on electricity. I took this and followed it through, working all the problems with a lot of interest and care. Then I took another course on electricity by mail, a more advanced one.

"By this time I had got to be an operator. In those days it was quite a different job from now. No well-organized maintenance crews to take care of all the trouble. I was supposed to be operator and emergency man, too. I don't know the equipment out there now like I did the old stuff. In those days men worked harder than they do now, anyway. Never thought much of working through two shifts when there was trouble in the plant.

He Thought He Was Fired

"While on the night operating shift one of the most important things to affect my career happened. One night things were pretty quiet and I began thinking about the electrical course I was taking. So I got out my lesson and was working away on an electrical problem in great shape when a shadow fell across my paper. A cold feeling came over me. I knew I had been caught. On jumping up I saw it was the superintendent at my side and that he was watching me. It was strictly against rules to read during the shift, and so I fully expected he would fire me right then and there.

"He asked me what I was doing. I told him that I was working an electrical problem in my correspondence course. Then I waited to be fired. Instead, however, he brought over a chair, sat down beside me and worked problems with me for more than an hour. And I had expected to be fired at once. Little did I know it then, but this was one of the most important moments in my career.

"A few months later the chief operating engineer died and the superintendent recommended me for the job. He fought so hard for me that I got it. There have been four changes in superintendents over me since then, but somehow none of them has fired me. That's the whole story. You see there was nothing out of the ordinary that I did."

Modesty was a strong characteristic of this man, and he really felt that way about it. But to me it was the best example I had seen where earnest attention to the job, combined with study and self-education, had brought results. And all the more striking by comparison with the other oiler, who had remained just where he started.

I recalled now that on several occasions I had seen Mr. Jackson busily engaged at his desk in the solving of an electrical problem. He was still following the policy of self-education. My thoughts turned toward the oiler who was still on the floor.

"The contrast between your job and your companion oiler's job is rather striking, Mr. Jackson. How is it you got so much farther ahead than he?"

"Both of Us Couldn't be Chief"

"Well," he said, "both of us couldn't be chief. When the job was open I was an operator. An operator, of course, had a better chance of being considered than an oiler."

Not content with this modest explanation, I questioned one of the men in the office when he and I were alone.

"Well," he said, "Fred Jones could have done worse. He has had a steady job for the last thirty-three years—never been laid off once. Saved some money, too. He told me about it. Enough to help him get along in his old age."

It seemed to be a case of lack of ambition. A steady, easy job, enough pay for a modest living, and a cautious thrifty temperament looking out for his old age. If he, too, had taken up the correspondence school course and had fitted himself for the next higher job, he would have been at least an operator in this or some other company.

The story seemed too valuable to keep to myself. On my next encounter with Mr. Jackson, I said, "There are young fellows starting as oilers in plants all over the country and your case, Mr. Jackson, would make a valuable example for many of them. Why don't you give them the advantage of your experience and the inspiration of your success?"

"The correspondence schools have been after me for a long time to let them use my picture and my name, but I really can't see how it could interest anybody," he replied.

"Your case is already an inspiration to me," I rejoined, "and I know that if you could help just one young engineer climb one round nearer his goal you would gladly forget your modesty and let your story be told."

"I never thought of it that way," he answered, "but I should like some young fellow to be impressed with the importance of studying his line of work and if you promise not to disclose my name you can use my little story as an illustration."

Demand Factors and Heat Balances in Plant of World's Largest Hotel—The Stevens

Adequate service at minimum cost was the goal of the engineers who designed the power and heating plant of the world's largest hotel, recently opened. Engineers will be interested in this brief summary of their studies

By J. A. SUTHERLAND*

NEARLY a year ago it was announced[1] that the owners of the Stevens Hotel had decided to install in that $26,000,000 edifice a power plant of their own to furnish light, heat, refrigeration and power requirements for the 3,000 guestrooms, with the attendant workrooms, employees' quarters, and public rooms. This decision was based on their satisfaction with the results attained in the operation of the LaSalle Hotel, applied to the new job through a detailed study of its requirements, with appropriate modifications in the charges for space rental and the like.

Loads for high- and low-pressure steam and for power and light in a hotel have a wide range in the demand at different hours of the day, and the hours for peak loads vary with the seasons. Unfortunately, the peaks for heat and light do not coincide exactly, although to a great extent they do during the eight months when heating is required in the building.

Beside the 3,000 guestrooms the hotel contains the largest banquet hall in the country, three smaller banquet halls, several restaurants and private dining rooms, with a full equipment of kitchens, bakeries, cold-storage spaces and storerooms necessary to operate these facilities to their capacity of some nine thousand persons. The hotel laundry, print shop, carpenter and upholstering shops, paint and maintenance departments for steam, plumbing and electricity are the largest provided for any hotel so far built. A special feature that will prove an attraction for this hotel is an exhibition hall of 35,000 sq.ft. of floor space with bronze-faced cabinets on the columns and side walls containing outlets for 115- and 230-volt direct current, compressed air and steam at high pressure, gas, hot and cold water and drainage. This hall has spacious assembly rooms adjoining and has a 10-ton elevator for the moving of machinery, providing ideal facilities for exhibitions.

A vacuum return heating system is installed, and the vacuum return is extended to the returns from the domestic water heaters and to returns from the absorption units of the refrigerating system, located in the service building. The primary refrigerating equipment consists of two steam-driven ammonia compressor units, each rated for 125 tons and two ammonia absorption units of the same capacity. The absorption

*Mechanical Engineer, Holabird & Roche, Chicago.
[1]See Power, July 6, 1926, pp. 32 and 33.

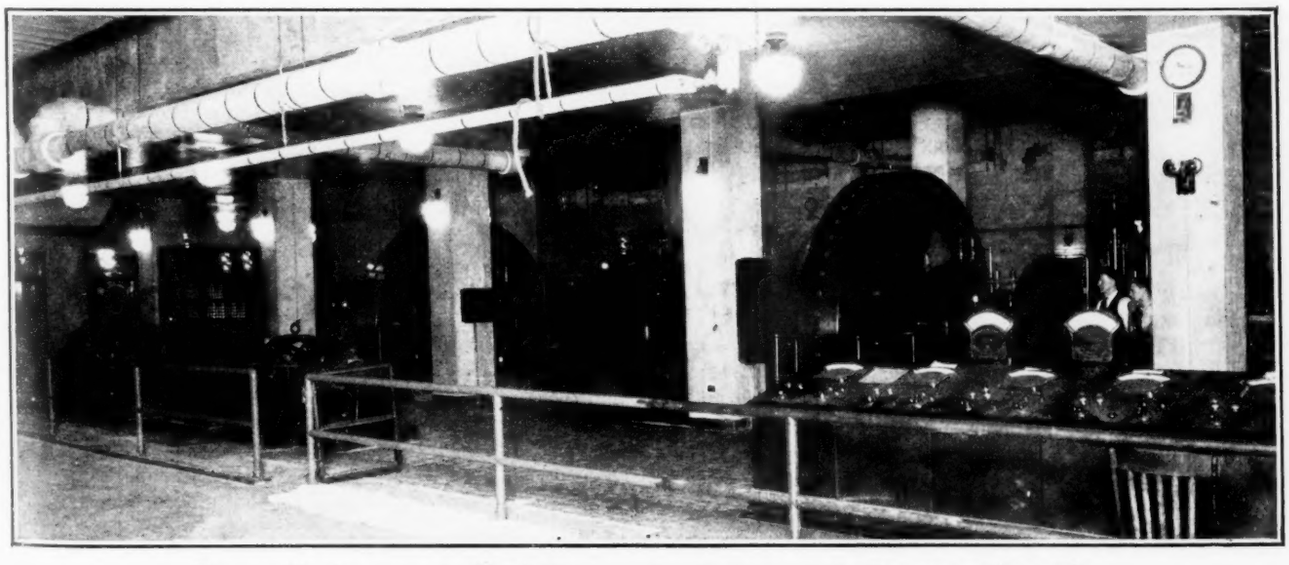


Fig. 1—Engine room in Hotel Stevens, showing two of the five generating units, bench control board and balancer sets at left

units are arranged to take steam from either a 2- or a 10-lb. exhaust line, the auxiliary steam-driven units only being connected to the higher back-pressure exhaust line.

Boilers are of the bent-tube type in seven units, with a combined heating surface of 45,320 sq.ft., all set over inclined chain grates capable of driving the boilers at 200 per cent of rating. In addition to the heating of the hotel and service building, these boilers are providing steam for the Eighth Street Theater and are intended ultimately to serve other buildings in the vicinity.

Five engine-driven generating units give an aggregate capacity of 3,100 kw. Three of the prime movers are cross-compound heavy-duty Corliss engines having

In this discussion the anticipated daily load will be taken for the several units, but only two variations in the loads for the summer and winter days will be assumed, although the load on a hotel varies also for mid-season days. For this brief article, an average has been taken, based on fair assumptions for the year.

Group 1 includes a strictly electrical load, and this consists of the 24 elevators and the dumbwaiters, the load on which is estimated at 1,200 kw.-hr. daily. It includes the ventilating supply-fan and exhaust-fan motors for air washers and cooling water, drinking-water motors, the vacuum-cleaning and pneumatic-tube motors, service-building house-pump motors, coal- and ash-handling motors and main air-compressor motors,

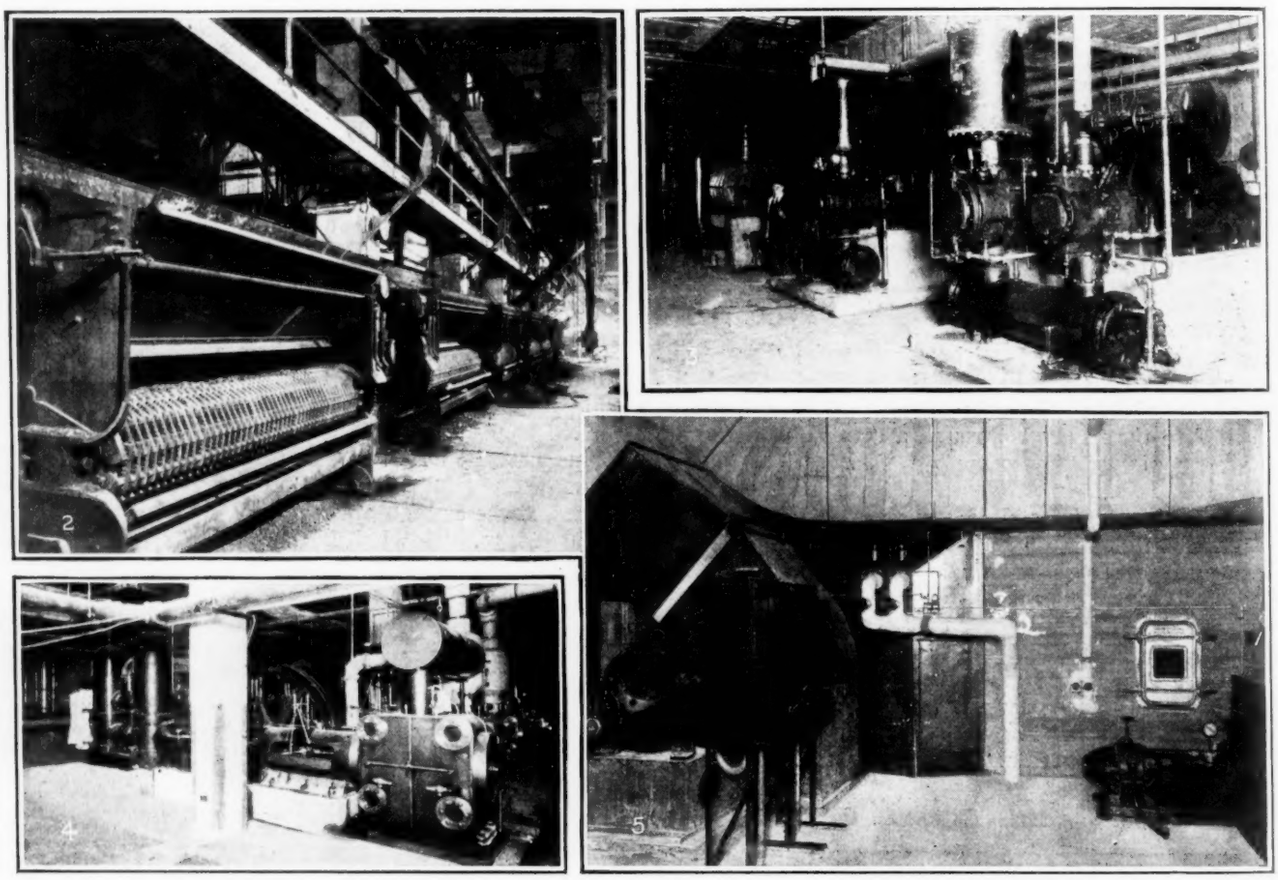


Fig. 2—Seven water-tube boilers equipped with natural-draft chain grates and operating at 175 lb. pressure. Fig. 3—Motor-driven air compressors and pneumatic-tube suction machines. Fig. 4—Cross-compound high-duty Corliss pumping engines, of 1,500 and 1,000 gal. per min. capacity, for house service. Fig. 5—One of the smaller air washers equipped with tempering and reheating coils and complete automatic control

a steam rate of 19 to 20 lb. per i.hp.-hr., and two are simple Corliss engines with a rate approximating 24 lb. In this equipment reliability and long life were made the primary requisites, with economy for non-condensing operation the deciding factor.

A rough grouping of the plant equipment follows, arranged to indicate a group that requires electric current for power or for lighting, a group that requires high-pressure steam from which the exhaust is available for heating or refrigeration, a group in which the units are installed for operation by high-pressure steam or by motors as desired, and a heating group that utilizes exhaust steam only, this group being also arranged to receive makeup steam from the high-pressure lines.

which total during normal operation some 990 hp., with the estimated load averaging 6,800 kw.-hr. daily. It includes also kitchen, laundry and shop motors with a total rating of 350 hp. and an estimated daily load of 1,200 kw.-hr. Aggregating some 2,600 kw. of full connected load, the daily lighting demand is estimated at 16,800 kw.-hr. This gives a total current consumption for light and power of 26,000 kw.-hr. daily.

Group 2, representing steam-driven units that exhaust to the heating system, is expected to provide steam for the heat units and for refrigeration.

Based on a daily demand of 26,000 kw.-hr. at an assumed rate of 35 lb. of steam per kilowatt-hour, the engine generators require daily 910,000 lb. of steam. The brine and ammonia pumps in connection with the

refrigerating system take 44,000 lb. The boiler feed, vacuum and small auxiliaries consume 22,000 lb. of steam. This gives an estimated total for the average day throughout the year of 976,000 lb. of steam.

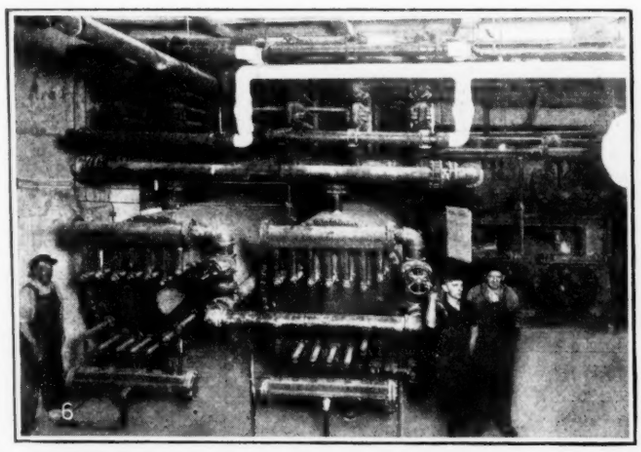
In the summer months the use of two ammonia compressors for air cooling calls for 36,000 lb. of steam per day, and during the winter months the use of one of these compressors in place of the ammonia absorption units requires 30,000 lb. per day. This brings the daily use of high-pressure steam during the summer months to 1,012,000 lb. and during the winter months to 1,006,000 lb.

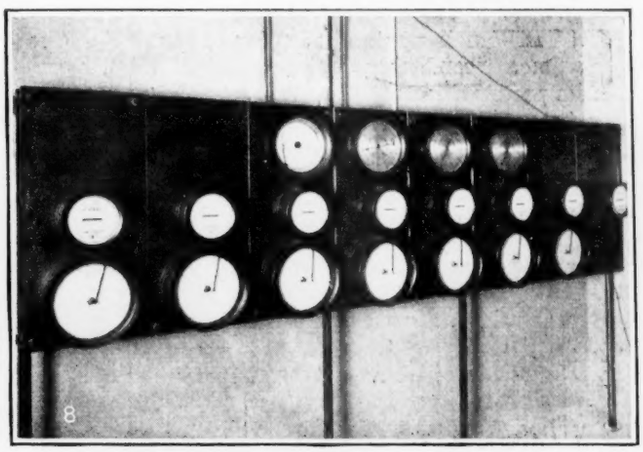
Group 3, comprising the main house pumps and the stoker drive, which are installed with either steam- or motor-driven equipment, is not considered here, because the use of either the steam or the motor-driven units will not materially affect the heat balance. The refrigerating system, owing to the arrangement of the steam-driven compressors cross-connected with the service from the ammonia absorption units, can be operated so as to balance the summer and winter steam demands. This will be seen more clearly in the exhaust-steam loads under group 4.

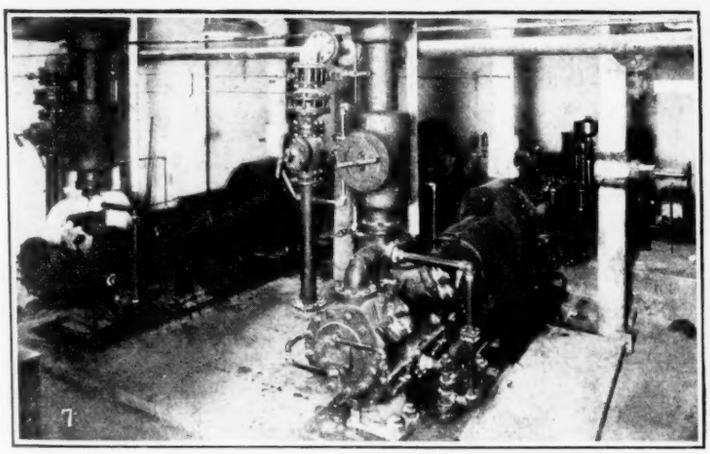
Group 4 comprises the heating units using exhaust steam only and includes ammonia absorption refrigerating units with an exhaust-steam demand during the summer months estimated at 204,000 lb. daily. During the same period the daily hot-water load is estimated at 530,000 lb. of steam and the boiler feed and other auxiliary items at 46,000 lb. This gives a total daily exhaust-steam demand during the summer of 780,000 lb.

During the winter months operation of the ammonia compressors, using high-pressure steam, in place of the absorption units, eliminates the necessity for exhaust to the refrigerating system and permits more exhaust going to the direct and blast-heating systems. The winter load on this group, then, is represented by the direct radiation, which is estimated to consume 290,000 lb. of steam daily, the blast coils in the ventilating systems taking 147,000 lb., the hot-water heating requiring 530,000 lb. and the 46,000 lb. for boiler feed-water heating and auxiliaries. The daily total during the winter months, then, is estimated at 1,013,000 lb. of exhaust steam, which slightly exceeds the steam required for power generation.

Summarizing the summer requirements to obtain a possible heat balance, and assuming that 85 per cent of the 1,012,000 lb. of high-pressure steam is available for heating, gives a total of 860,200 lb. against a consumption of this steam at the rate of 780,000 lb. per day. These figures indicate a daily loss to atmosphere, during the summer of 80,200 lb. of steam, or a total steam loss during a four-month period of 9,624,000 lb. This latter figure is about 2.6 per cent of the total steam generated per year, and at 60c. per 1,000 lb., the money equivalent of this lost steam would be $5,774.40.







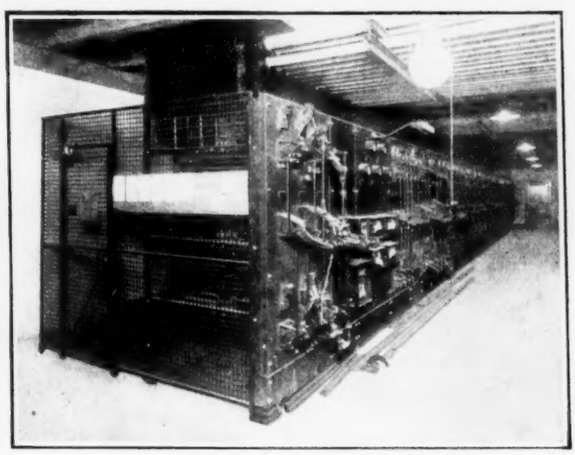


Fig. 6—Absorption refrigerating plant of 250 tons capacity, showing the two generators, rectifiers above and heat exchangers at right. Fig. 7—Two 125-ton feather-valve uniflow ammonia compressors for air cooling. Fig. 8—Meter board in engineer's office containing steam-flow meters and pressure and vacuum gages. Fig. 9—Main distributing switchboard containing 24 panels

Modern Shell and Tube Ammonia Condensers

Construction and Operation of the Latest Types of Shell and Tube Ammonia Condensers Used in Refrigerating Plants—Single-Pass Multi-Tube Types—Features of Construction—Operating Characteristics

By W. H. MOTZ

IN VIEW of the general adoption of the shell-and-tube ammonia condenser engineers should learn more of its peculiarities. Although these condensers may be constructed in various manners, the current types may be divided into three classes, as follows: Vertical, single-pass, multi-tube; horizontal 7-pass, 7-tube; horizontal 7-pass, 28-tube.

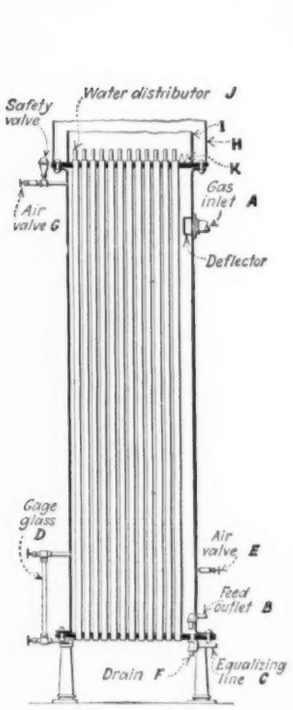


Fig. 1—A typical vertical condenser

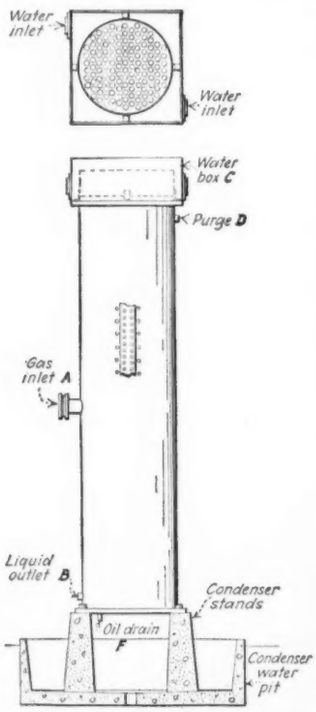


Fig. 2 — Vertical condenser with side inlet

A type of construction of the vertical single-pass multi-tube condenser is illustrated in Fig. 1. This consists of a welded shell that has flared ends riveted to heavy tube sheets and a number of charcoal iron tubes. The ammonia gas inlet is at the point *A*. In order to provide for a more even distribution of the gas at the inlet, a special deflector is attached to the inlet nozzle as shown.

The ammonia is condensed on the tubes, collects in the bottom part of the shell and is drained off at the feed outlet *B*. An equalizing line is provided at *C*. A drain is installed at *F*, while purge connections may be made at points *E* and *F*. A circular water box *H* is attached to the top sheet, and a special water baffle *I*, having serrated edges *K*, is placed within the water-box as shown. Water-distributing devices *J* are placed on the top end of each tube. These distributors are made of cast iron and are hollow, with spiral grooves or slots at the base. The water passes through the spiral grooves and flows in a corkscrew motion down on the tube. A certain amount of air is drawn in through the hollow cores of the device.

Welded Shells in Use

Another type of shell-and-tube condenser is shown in Fig. 2. This consists of a double-riveted, double butt-strap shell having flared ends welded to heavy tube sheets. The hot gas inlet is at point *A*, which is at the center of the shell. The liquid outlet *B* is provided at the bottom of the shell. A square water-box *C* is attached to the upper tube sheet; a purge connection is provided at the point *D*, and an oil drain connection is installed at the point *E*. Suitable stands and water-collecting basin are shown.

The tubes are rolled into grooves in the tube sheets, to secure tight joints. Water-distributing ferrules having serrated edges are used to admit water to the tubes. A water baffle, elevated above the tube sheet, is provided to give a uniform distribution of the water to the ferrules. The water is admitted at two points to the water-box as shown.

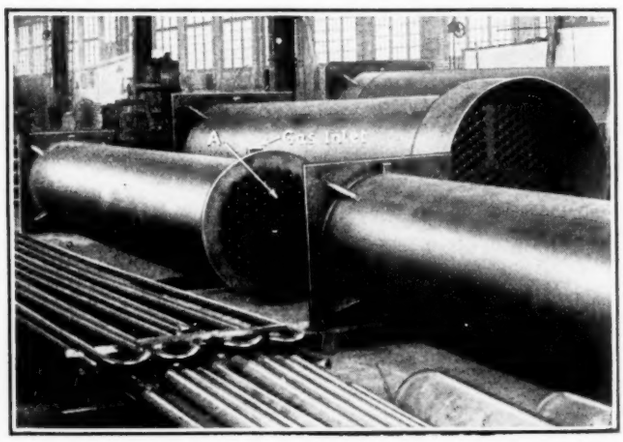


Fig. 3—Condensers in process of manufacture

Another type of construction of shell-and-tube condensers is shown in Fig. 3. The principal feature in this type is the omission of a number of tubes, as shown at *A*, opposite the hot gas inlet, to allow a more even

distribution of the hot ammonia gas to the tube surface. The hot gas inlet nozzle is close to the top of the shell. The top tube sheet is circular, with a steel water-box welded to it and the bottom tube sheet is square, as shown.

The water-distributing devices are removable and may be cleaned while the condenser is in operation. The tubes may be cleaned by simply removing the water-distributing devices and by working a tube cleaner up and down in the tubes. In installing such condensers, proper headroom should be provided so that the tube cleaner may be used without difficulty.

In some instances the lower part of the shells may be used as a liquid storage, but I believe that such condensers should be run empty, so that all the tube surface is used for condensing the ammonia gas.

The types of condensers shown have practically a parallel flow of water and ammonia. However, this type of condenser will usually cool the ammonia to within 3 to 8 deg. of the water-outlet temperature.

Counter Current Possible but Not Necessary

The shell-and-tube vertical condenser may be made to operate on the counter-current principle by inclosing the water-boxes at the top and bottom so that the water enters at the bottom box under pressure and leaves by the top box.

When hollow water-distributing devices are used and the water flows in a film down the inside of the tubes, a certain amount of air is drawn into the core of the tubes. The action of the water and the air in this case is to produce a certain amount of so-called atmospheric cooling effect. This tends to keep the water at a lower average temperature, although the effect is slight.

The first cost and erection costs are not excessive,

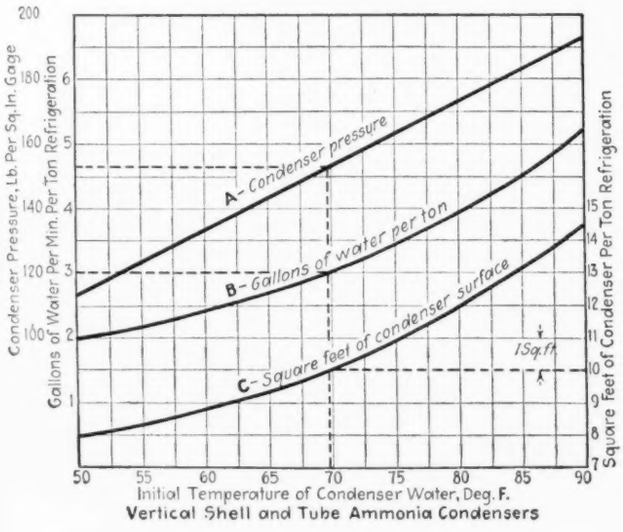

Condenser Pressure, Lb. Per Sq. In. Gage
Gallons of Water Per Min. Per Ton Refrigeration
Square feet of Condenser Per Ton Refrigeration
A- Condenser pressure
B- Gallons of water per ton
C- Square feet of condenser surface
1 Sq. ft.
Initial Temperature of Condenser Water, Deg. F.
Vertical Shell and Tube Ammonia Condensers

Fig. 4—Characteristics of single-pass condensers

and the condenser acts as gas receivers for the compressor, thus tending to reduce friction losses and pressure pulsations.

The average operating characteristics as to pressure, water requirements and surface requirements are shown by the curves in Fig. 4. Curve *A* gives the probable condenser pressure for various initial temperatures of condenser water. The water requirements in gallons per minute per ton of refrigeration are found from *B*, and curve *C* gives the tube surface in square feet per ton of refrigeration.

These curves are based on the assumption that the tubes are kept reasonably clean and that the non-condensable gases are kept down to a small percentage.

A construction of the horizontal 7-pass 7-tube ammonia condenser is illustrated in Fig. 5. This condenser consists of a number of 8-in. tubes *A* each containing seven 2-in. pipes *B* rolled into grooves in the

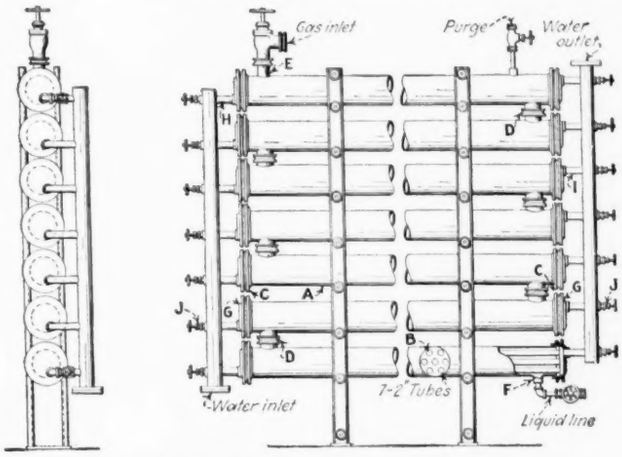


Fig. 5—A new design of horizontal condenser

heavy flanges *C*. The 8-in. tubes are connected by flanges and nozzles *D* at the opposite ends as shown. The hot ammonia gas is admitted to the tube at *E*, and the condensate is drained from the lower tube at the point *F*.

The water heads *G* are so arranged that the water makes seven passes through each 8-in. tube. Each 8-in. tube has a water inlet *H*, a water outlet *I*, and gate control valves *J*. Proper water headers are provided as shown. Water at the temperature of the original source is in this manner supplied to each 8-in. tube. The ammonia flows over the 2-in. tubes and then downward through the series of 8-in. tubes.

The water headers are offset, so that by closing the gate valves, opening the unions, and removing the water-head bolts, the water heads may be removed and the tubes cleaned while the condenser is in operation. Owing to the arrangement the friction of water flow through each 8-in. tube is equalized, which means that under the same conditions of valve setting, etc., the same amount of water will flow through each 8-in. tube.

Condensing Surface Small

This type of ammonia condenser has some quite interesting operating characteristics. Fig. 6 gives the characteristics of pressure, water requirements and surface requirements. Curve *A* gives the condenser pressure for various initial water temperatures, curve *B* gives the water requirements in gallons per minute per ton of refrigeration and *C* gives the corresponding surface requirements in square feet per ton of refrigeration.

From an inspection of Fig. 6 it will be noted that this condenser requires a comparatively small amount of tube surface per ton of refrigeration capacity. This is due to the fact that the heat transmission rate is exceptionally high.

The 7-pass, 7-tube condenser requires a minimum amount of space for installation. Owing to the type of construction, stuffing box and gasket troubles are practically eliminated. It has flexibility of operation.

since it may be cleaned while in operation, and a section may be cut out of service by closing the gas inlet valve and the liquid outlet valve.

The sections may be made six to seven pipes high, and various capacities are obtained by using the proper number of sections. By using smaller tubes and pipe, the same design may be used on plants of small capacities.

The Latest Design

The construction of the 7-pass, 28-tube horizontal ammonia condenser is illustrated in Fig. 7. This consists of multi-tube sections *A* made up of 16-in. pipes, 20 ft. long. In each 16-in. pipe are twenty-eight 1¼-in. tubes, suitably connected to the tube heads. The hot ammonia gas is admitted to the 16-in. pipes at the valves *B*. The ammonia gas passes along the tubes and is condensed, and the condensate collects along the lower part of the 16-in. pipe and is drained off through the valves *C*. A suitable gas header *D* and liquid header *E* are provided. Pump-out connections are provided at points *F*.

The water for the condenser is led into the water header *G* and passes through valves *H* into the condenser heads *I*. These heads are baffled so that the water is split up into four parts, and each part is then made to flow in seven passes through the condenser, being discharged through a similar head at the opposite end of the condenser into a water-outlet header.

The ammonia liquid header *E* is connected to the ammonia receiver *K* through valve *L*; the receiver and

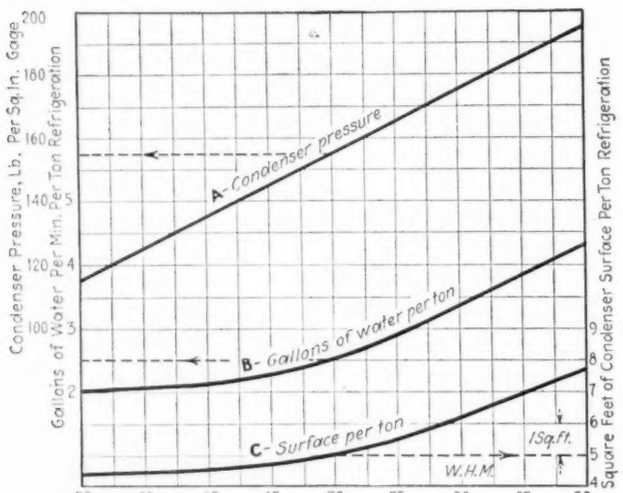

Condenser Pressure, Lb. Per Sq.In. Gage
Gallons of Water Per Min. Per Ton Refrigeration
Square Feet of Condenser Surface Per Ton Refrigeration
A- Condenser pressure
B- Gallons of water per ton
C- Surface per ton
1 Sq.ft.
W.H.M.
Initial Temperature of Condenser Water, Deg. F.
7-Pass 7-Tube Ammonia Condensers

Fig. 6—Operating characteristics of condenser in Fig. 5

condenser may be supported on a steel framework as shown.

One of the features of construction used in this condenser is the method of connecting the tubes to the tube heads. The tube heads are drilled to receive the tubes and these holes are counterbored to receive a rubber packing ring. A slotted packing nut operating along the threads on the tube is used to obtain the desired compression upon the rubber ring. When the slotted packing nuts are screwed up properly, the rubber ring makes a gas-tight joint between itself and the tube head and tube. The principal advantage of this type of construction is that the joint remains tight under repeated expansion and contraction of the tube. Another advantage lies in the fact that construction permits replacement of a defective tube with a minimum of labor and time.

In the original design and construction of this condenser the model was tested for tightness of joints by

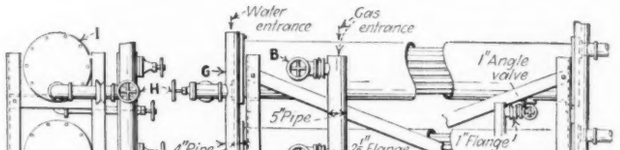


Fig. 7—A 7-pass, 28-tube condenser

connecting a steam line and a fire hose to it, and by then admitting steam and water alternately into the condenser. The joints remained tight under this critical test.

The condenser is flexible in operation owing to the fact that a section may be cut out of service by simply closing the two ammonia valves. It is easily cleared or repaired and, of greater importance, a good rate of heat transfer is obtained.

Another List of Questions

By Alfred A. Markson

Ques. 1—Why do they call it a Scotch boiler?
Ans.—Because the tighter the better.
Ques. 2—What is meant by "Y" connection?
Ans.—Phoning the wife that you're at the Y. M. C. A.
Ques. 3—What is a blower?
Ans.—Efficiency engineer.
Ques. 4—How would you take care of a dry vacuum ump?
Ans.—Give it an occasional drink.
Ques. 5—What is meant by star-connected?
Ans.—Being hit by a falling bolt.
Ques. 6—What is "overall" efficiency?
Ans.—Wearing a pair for four years without having them washed.
Ques. 7—Where do the firemen take a nap?
Ans.—On the fuel bed.
Ques. 8—What is an economizer?
Ans.—A Scotch engineer.
Ques. 9—What is steam packing?
Ans.—Sending the office boy for a pail of steam.
Ques. 10.—What is a forced-draft fan?
Ans.—A chap forced to display enthusiasm as his best girl prattles about sleeping with all the windows open.

It Takes 135,000 pounds of mercury to fill the new mercury boiler for the South Meadow Station at Hartford, Conn. At $1.25 per pound this would cost $168,750. Fortunately, one filling lasts a long while.

A Blessing in Disguise

A DISTINGUISHED British visitor recently remarked upon departing, after a five-weeks' tour of this country, that he had seen many marvelous things, but had failed to note any indications of a coal strike. This is just added evidence that the strike has failed to create a ripple in our industrial life, aside perhaps from increasing the revenues of certain railroads at the expense of other carriers.

On the other hand, many power plants in the Middle West have benefited as a result of the strike, in that they have changed from high-sulphur Illinois or Ohio coal to a good grade of West Virginia coal, from the non-union fields. Increased evaporation, ease of burning and saving in maintenance in most cases more than offset any advance in price due to longer haulage. Doubtless, many of these plants will continue to use this coal; thus the strike will have had a beneficial effect at least so far as certain power plants are concerned.

The Leadership of the N.E.L.A.

ENGINEERING is far from the whole interest of the National Electric Light Association, meeting this week at Atlantic City, but that organization includes many of the leaders in this country in the field of sound power-plant engineering practice.

A convention of the entire organization holds sessions on topics of commercial and administrative interest, as well as upon technical matters in the field of power generation and of electric generation, transmission and distribution. These meetings are largely confined to committee reports and sometimes appear uninteresting and perfunctory, but one must remember that they present the results of an immense measure of intensive work by large and highly competent committees.

Every power-plant engineer owes a large debt of gratitude to the N.E.L.A. for the work it has initiated or encouraged in the development of improvements that are made available to the entire profession through their committee reports. Representing an industry whose whole manufacturing function is the production of power at minimum cost, the Association and its members have prosecuted vigorously many studies of possibilities and have put the more promising to the test of actual plant construction and operation. Undaunted by difficulties, they have pushed many of these trials to ultimate commercial success. Without their determination and courage and resources in knowledge and money, progress must have been slower, and the entire art of power generation must have gained less than it has.

All honor to the National Electric Light Association.

Insurance and Inspection

POWER-PLANT insurance and insurance against service interruption, whether power be privately generated or purchased, is deemed of sufficient importance in industry for the United States Chamber of Commerce to issue a special bulletin dealing with its several aspects. Excerpts from the bulletin appear elsewhere in this issue.

Liking power supply in industry to the heart in the human body, the Chamber rightly stresses the value of engineering inspection service in reducing outages and preventing losses, both direct and indirect.

Engineers need no conversion to the idea, but managements are sometimes slow to appreciate the value of such inspection. That the National Chamber of Commerce has seen fit to take up the matter may carry conviction to some who, heretofore, have been inclined to take a chance.

Watch the Insulation's Condition

ONE of the reasons given for the prevalence of leaky steam, air, water or oil lines, is that these leaks may continue for a long time and, outside of probably creating a disagreeable condition, may not cause any trouble that makes necessary a repair of the defect. All the time that these leaks exist they represent a loss in heat or power, which in some installations has reached considerable proportions. There is a general belief that such leaks cannot exist on an electric circuit without producing a condition that will require immediate attention. This idea is based largely on a false premise, that all grounds are of low resistance and that all leaks over or through insulation soon develop into low-resistance short-circuits.

Those experienced with ground connections know how difficult it is to obtain a low-resistance ground and to maintain the resistance low after it is obtained. If a good connection is made to a water main, a low-resistance ground is obtained at this part of the circuit, but an accidental ground on another leg of the circuit may have a comparatively high resistance. Where grounds are obtained by artificial means, such as by driving pipes into the earth or by buried plates, the resistance of the ground connection may be almost anything, depending upon the kind of soil and the attention given to maintaining the earth connection. Tests have shown that an iron pipe driven into the earth may have a resistance of from five to fifty ohms. On large low-voltage power systems such ground may exist without causing any inconvenience in operation. When grounding such systems mistakes have been made, and instead of making all the ground connections to the neutral, one has been made to an outside leg of the circuit, so that two lines were grounded permanently. This condition had existed for a long time before it was discovered.

Conductors run in wet places may get into such a condition as to allow a large current leak without being detected. Large conductors have been entirely corroded in two, owing to current leaks that were not discovered until an open developed in the circuit. In another instance repairing the insulation on a heavy power circuit reduced the load on feeders about a hundred amperes.

These examples may represent extreme cases; nevertheless they show that leaks of serious proportions can exist on electric circuits without causing an effect that will make repairs necessary, just as they can on a steam or water line. On the fluid line there is usually an external manifestation that will call attention to the defect. In the electric circuit the defect may exist for a long time without its presence being made apparent by visible indications. There is only one sure way of knowing what the conditions of an electric circuit are, and that is by periodic tests. Unless these are made, leaks may exist that represent appreciable losses and may develop into faults that will require repairs at an inconvenient time.

Weighing Pulverized Coal

ONE of the difficult problems that has arisen recently is the weighing of pulverized coal. This is hard to do because so far nobody seems to have made a coal valve that will be sufficiently easy to operate and at the same time be tight when closed. With a valve admitting coal to each weigh tank and another valve to let the coal flow out, if the valves leak, more coal goes through the outfit than the scales indicate, because coal will leak out of the tank during the filling period, before it is weighed, and coal will leak into the tank during the emptying period. All of this means that plant efficiency figures based on the weighing of pulverized coal may be too good; that is, the plant may not be charged with all the coal it has burned. This does not apply, of course, to pulverized-coal plants that weigh the coal before it is powdered, but only to plants that base their results on weighing the fine powder.

Fortunately, this situation is fully realized and several plants burning pulverized coal are hard at work on the problem. To co-ordinate their efforts, it is proposed to include the problem among the research projects fathered by the A.S.M.E. Committee on Research.

The development of a dependable method of weighing coal after it is pulverized would be a good thing. It would give the plant designer a little more flexibility in arranging his equipment and would make it possible to determine the coal burned by individual boilers. Meanwhile, the engineer must take a little pinch of salt with efficiency values based on determinations with present equipment. They may be right, and they may not.

Industrial Power Records

IN TWO papers on management of industrial power presented at the Spring meeting of the A.S.M.E., the viewpoints of the executive and of the engineer were set forth. Both agreed that complete records should be kept of power costs and operating data. The engineer maintains that these cost accounts should be based on units of energy output.

Power stands back of the engineer's viewpoint and believes the executive will reap the larger benefit from operating data and costs based on kilowatt-hours of energy output or thousands of pounds of steam per hour. Such accounts allow comparison either with similar industrial plants or with central-station power costs. This enables the executive to determine whether his plant is operating efficiently and also whether it would be economically justifiable to buy central-station power. Operating records serve to keep the power-plant crew on the job, as they know that the plant performance, which is to a large extent a measure of their ability, is being watched daily. It further enables the executive to watch closely the increase in demand for heat, process steam and power of his factory as a whole and of the individual departments in it. From these observations he can determine when the capacity of the power equipment must be increased to avoid factory interruptions.

Engineering accounts look like a complicated subject, and many an executive is convinced that he never can understand a bit of it. If he will study intelligently only a few fundamental engineering relations, he will find it no more difficult than analyzing his financial reports. The executive who bestirs himself and works into a knowledge of engineering sufficient to understand his engineers' reports may find that some of the improvements asked for are worth while.

Now is a good time to begin.

What limits the length of turbine buckets? One naturally tries to think of some elaborate reason involving the linear velocity of the base and tip of the bucket, the velocity of the steam jet, the spilling of steam from the end of the bucket, and so on. But it seems that these things have nothing to do with the limiting length. An experienced designer with one of the large turbine manufacturers says that the limit is in the strength of the buckets to support the weight of a man standing on the tip of the buckets when the wheel is lying on its side, as when the rotor is up-ended during assembly. Of course nobody ever should stand on the buckets, but sooner or later somebody will do what he shouldn't, and the buckets must be strong enough to stand the gaff. At that, many a bucket failure may be due to somebody jumping on the buckets or dropping something on them.

An examination of costs and selling price in a number of industries reveals that the profit margin is decreasing. There is reason to believe this tendency is becoming general, and executives will be forced to study ways of cutting costs in every department. Power has often been classed as a minor cost item too insignificant to warrant any great expenditure for improvement. If in the future the manufacturing margin drops to five per cent and the power costs be five per cent, it is obvious that a reduction of fifty per cent in the power expense will increase the profit margin by fifty per cent. It follows that the enterprising engineer faces a hopeful future, for the power plant will eventually become the important manufacturing department.

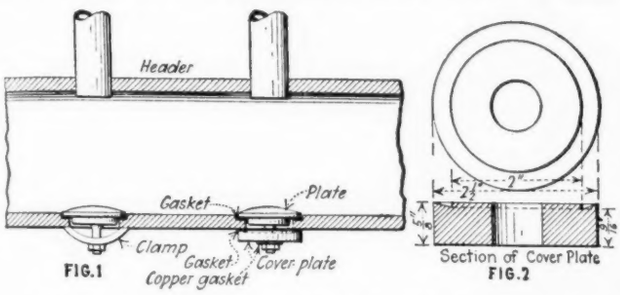
When reheating as applied to steam turbines became necessary two or three years ago, in consequence of adopting high steam pressures, many predictions were made as to what would happen if the load should suddenly fall off. In one or two of the first plants to adopt reheating, rather elaborate precautions were taken to handle automatically such a situation. Experience has shown that this is unnecessary.

Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

How Leaks in Superheater Were Stopped Temporarily

In our plant we had trouble with gaskets blowing out on the small tube plates on the superheater header in a waste-heat boiler. As the boiler could not be opened for inspection, on account of letting air into the setting and causing an explosion, the steam would blow for probably a week before it was noticed, and consequently cut the seat to such an extent that it had to be welded.



Usual clamp on the outside of the header was replaced by a copper plate

For a quick repair cover plates were made to go on the outside of the header in place of the usual clamp, as shown in the illustration. A gasket of thick sheet packing was placed under the cover plate and a copper gasket under the nut. The reason for using a thick gasket under the cover plate was to conform to any irregularities in the surface of the header. The boiler was shut down for a few hours on Sunday and the plate put on. This repair was satisfactory, as there was no sign of a leak two months later. L. M. LARSON.

Duluth, Minn.

Poor Contact in Circuit Breaker Caused Motor Trouble

A number of years ago, when I was just beginning work on a new job, which consisted of operating a compressor driven by a 150-hp. three-phase induction motor, I ran into a trouble that baffled me for a couple of days. The motor would start and run for about fifteen minutes and begin to hum, after which the circuit breaker would open and the motor would stop.

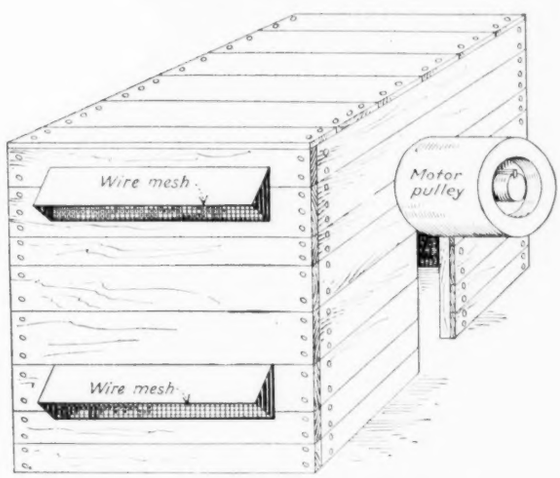
The motor circuit breaker was of the three-pole type and was connected into the line ahead of the starter. While starting the motor, one had to hold the circuit breaker in with one hand and operate the starter with the other, as the breaker was set for the full-load current of the motor, while the starting current was considerably above this value.

After several tests were made on the motor and wiring, it was discovered that as long as the circuit breaker was held in tightly by hand the motor operated satisfactorily. Soon after the circuit-breaker handle was released, the motor would hum and the current, as shown on the one ammeter, increase until the breaker opened. This showed that the trouble was in the breaker and that when the handle was released one set of contacts opened and caused the motor to run single-phase. When the circuit breaker was opened, it was found that the adjustment on one contact had slipped and allowed this contact to open when the handle was released. Readjusting the contact cured the trouble.

Butte, Mont. FRED W. GOLDSMITH.

A Change from Engine to Motor Drive That Saved Money

When I took charge of a job some years ago, I found that the company had rented a steam engine from a local machinery company for driving a circular saw, and was paying $15 a month for its use. As 440-volt three-phase current was available within 75 ft. of this engine, I made a deal with a local electrical company and purchased a 15-hp. motor for $150, making a down payment of $15 and $15 a month. The motor was paid for at the end of ten months, and as the kilowatt-hour rate



Motor was covered with ventilated box

was low, the cost of operation was hardly noticeable at the end of the month on the company's power bill, while the difference in the coal costs was.

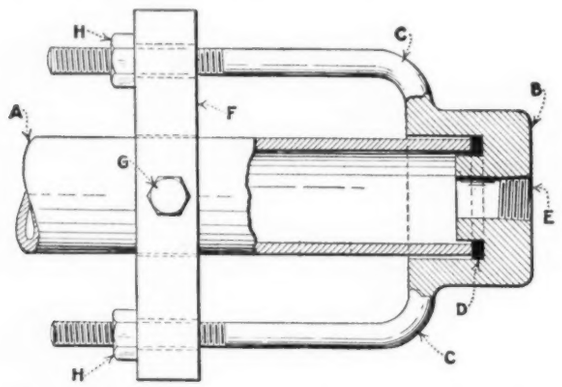
As this motor was located out of doors the year around, the carpenter constructed a water-tight box around it, allowing the shaft and pulley to extend through the side of the box. In the sides of the box, ventilating openings were cut, which were covered with fine-mesh screen, as shown in the figure. The motor never gave the least sign of overheating, which indicated that ventilation was ample.

Butte, Mont. FRED W. GOLDSMITH.

Rig for Testing Open-End Pipe and Tubes

The illustration shows a device we have found useful and practical for testing pipe or tubes without threads.

A is the piece of pipe to be tested by compressed air. In this case they were hairpin bends of 1¼-in. pipe and were about 30 ft. long and without threads. Part *B* was turned out of steel shafting and the draw bolts *C* were welded to it. *F* is a piece of steel bored



How the air connection is clamped on the end of unthreaded pipes and tubes

a loose fit on the pipe and drilled for the draw bolts *C* to pass through. A setscrew *G* holds this in position. The nuts *H* are tightened up, and the rubber washer *D* makes a tight joint. Two of these fittings are used, one on one end for the source of air through *E* and the other for the release of the air. This device is also readily adaptable for testing boiler or superheater tubes.

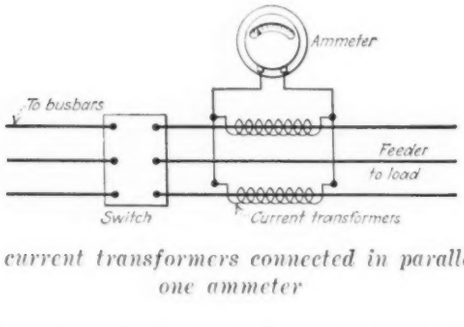
D. A. WARRINER.

New Orleans, La.

Wrong Transformer Connections Cause Improper Loading of Turbine

Some years ago I was engaged as chief engineer of a lumber manufacturing plant, the owner of which was noted for his ability to secure his employees for the least possible expenditure. At this time the plant had been in operation three months, but during that time and the construction period there had been three different chief engineers on the job.

The engine-room equipment consisted of a 500-kw. 440-volt turbine-driven generator and a 200-kw. engine-driven generator, both of them second-hand. The remainder of the power, about 700 kw., was obtained from



Two current transformers connected in parallel to one ammeter

a public utility company. The generators were each driving a separate section of the mill, there being no provision for paralleling them.

The first thing to attract my attention was that the inlet pressure gage on the turbine registered only 65 lb., while the boiler pressure was 125. This occurred with the ammeter on the generator panel indicating 700 amperes, while nameplate rating of this machine was only 600 amperes. There were two feeder circuits on this generator, the ammeter on one reading 300 amperes, the other 400—a total of 700, the same as the generator ammeter.

This did not appear to be right, as the inlet gage on the turbine indicated about half load and the ammeters over full load on the generator. On testing the inlet gage, it was found to be correct, but upon tracing out the connections on the feeder ammeters, it was found that the two 1,000- to 5-ampere current transformers on each feeder were connected in parallel to the one ammeter, as in the figure, thus giving approximately a double reading.

The ammeter on the generator panel was graduated to 1,000 amperes, but the current transformer had a 500 to 5 ratio, so that this ammeter also was indicating twice the actual current. After correcting the connections on the feeder ammeters, replacing the 500- to 5- with 1,000- to 5-ampere transformer and providing connections to parallel the two generators, we were able to take 400 hp. more motor load on our plant. After this, the inlet pressure on the turbine came up to 120 pounds.

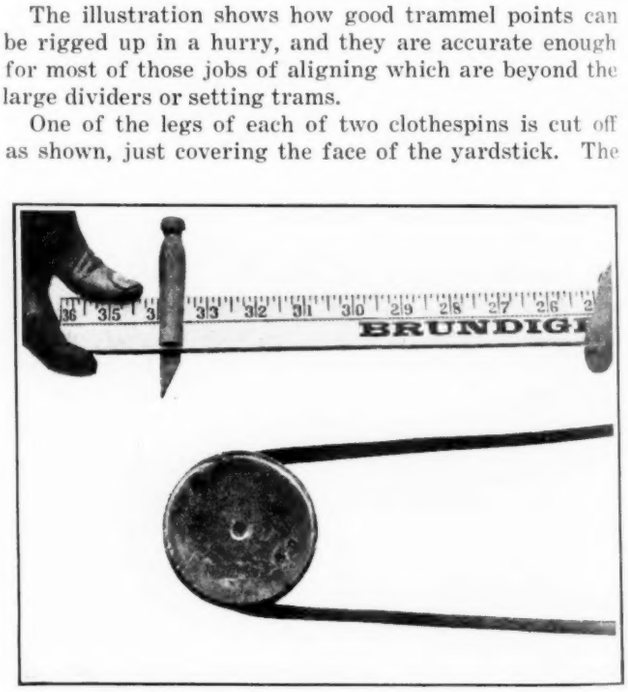
G. W. WIRTANEN.

Great Central, B. C.

Home-Made Trammels

The illustration shows how good trammel points can be rigged up in a hurry, and they are accurate enough for most of those jobs of aligning which are beyond the large dividers or setting trams.

One of the legs of each of two clothespins is cut off as shown, just covering the face of the yardstick. The



Trammels made with a yardstick and clothespins

other legs are sharpened to a good point. The pins can be readily slipped along the stick to measurement, or to points or centers. As the pins are light, the stick does not bend no matter how you hold it.

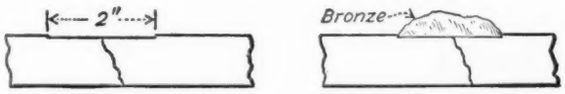
It costs nothing for material, is easy to make, and is quite practical for many of those jobs of laying off or aligning which we frequently do in a hurry or perhaps with a more crude device than this simple affair.

Missouri Valley, Iowa. F. W. BENTLEY.

Comments from Readers

Bronze Welding a Gas-Engine Head

Referring to the article on "Bronze Welding a Gas-Engine Head" in the April 19 issue, by J. F. Eldee, I have had good success in brazing cracks in certain cast-iron parts by merely grinding a smooth place an inch wide on each side of the crack and piling up a thick ridge of Tobin bronze over the crack. The size of this ridge will depend on the strain the casting is required to



Crack is brazed with Tobin bronze

withstand and the direction in which this strain is applied.

Several years ago this method was applied to a triplex tar-pump cylinder which had the entire bottom punched out and broken. A new piece was made of ½-in. steel plate and dished. It was then brazed with bronze and is still O.K. L. S. VOIGT.

Granite City, Ill.

"Accident Sense" in the Power Plant

I read with interest the article by F. P. Terry in the April 26 issue on "Accident Sense in the Power Plant," as I have had considerable experience in accident prevention work in large establishments.

One of the most important factors contributing to the success of any industrial accident prevention campaign is the prompt investigation of all accidents and fixing the responsibility. Many complex problems must develop and it is necessary to consider separately and impartially each factor involved, finally announcing a decision based solely on facts. In most cases there is some basic cause for accidents and generally someone is responsible. The fault may be that of the injured workman or his mate; or the responsibility may rest with the foreman who has charge of the men, or with the management. The responsibility is there, and it should be definitely allocated in every instance to the man, method or material.

Accidents may be divided into two classes—those for which the employer is directly responsible and those for which the employees are primarily if not entirely to blame. It is an employer's responsibility to see that his power plant, or factory is properly lighted, that the danger points on the machines are effectively guarded, that the operations carried out are carefully considered from a safety viewpoint and that the employees are properly instructed as to the possible risks of injury.

Experience proves that many accidents, for which employees are themselves chiefly responsible, are due to a certain recklessness and light-hearted acceptance of risks, which are prevalent among the young employees, and to the thoughtlessness, carelessness and inattention to which most of us are prone. Carelessness on the part of employees is admittedly the largest element in preventable accidents, being rated by some authorities at about double that due to faulty equipment.

As it is generally impractical for employers to be in immediate contact with their workers, they must invest their superintendents, managers and foremen with the same authority and responsibility in accident-prevention work that they do in maintaining production. The attitude of the superintendent, or manager, is reflected in the foreman, and that of the foreman in his men. It is therefore most important that the power-plant superintendent or chief engineer be imbued with the right ideas of safety.

It should be the duty of all in industry to assist in stimulating the unimaginative and guiding the inexperienced. Power-plant superintendents should set the lead by causing appropriate notices to be displayed, drawing attention to possible causes of injury and if possible, indicating the means of prevention. It is well known that danger signs play an important part in accident prevention work, and wherever necessary the danger-sign should be made a statutory requirement.

Not infrequently, inexperienced workers are placed in positions of danger to themselves and in many cases to others, and unfortunately many fatal accidents have been recorded, which, if a little precaution had been taken, would not have happened. The following are a few cases in point. Two men were scalded to death in a boiler, due to the opening of a valve; a man was crushed to death by the starting of a locomotive; another was fatally injured in the crankpit of a marine engine. No one perhaps is criminally liable; want of forethought is usually the cause. The following points are suggested as an aid to reducing accidents.

When steam boilers are being cleaned or undergoing repairs, means should be adopted to prevent steam or feed water being turned into them. All valves on the steam connection, blowoff pipe and feed-water pipes should be locked closed with a substantial padlock and danger tags attached. A metal plate about 18x12 in. which has painted on it in 2- to 3-in. white letters on a red background, such as DANGER—MEN WORKING INSIDE or CAUTION—MEN WORKING INSIDE, may be hung on the boiler front so that the firemen can see it, and another fixed on the back of the boiler. Also for the prevention of accidents to men working inside boilers, a thin plate inserted as a blank flange in the joint between the valve and the boiler will add to the safety and also stop the water coming into the boiler from a leaky valve.

In conclusion, it might be added that accident prevention work is today recognized as a necessary adjunct to the successful operation of power plants and industrial establishments, either large or small. It is important at all times, from both a humanitarian and an economic viewpoint, and there can be no greater aim than that of preventing accidents so far as possible.

Manchester, England. E. ANDREWS.

What Makes a Safety Valve Chatter?

I have been reading the Questions and Answers in the May 10 issue, and No. 6 interested me particularly because the question as to what makes a safety valve chatter has been bothering us for a long time. The answer given on page 710 is correct to a certain extent, but it is far from complete. An engineer should know that there are many causes for safety valve chattering or fluttering and should be posted on each cause in order to solve the trouble.

Too wide a seat may cause fluttering, but more often this trouble is caused by the placing of a length of pipe or fitting between the valve and the boiler. It is a well-known fact that in passing steam through a pipe, the outlet pressure is somewhat less than the inlet pressure. Consider, then, a pop valve set at 100-lb. pressure installed at the end of a pipe of sufficient length so that, in addition to the instant drop in pressure that takes place in the boiler when the valve opens, the total drop in pressure at the valve seat is 5 lb., making the blow-down or closing pressure of the valve 96 lb., or a 4-lb. drop.

As soon as the valve closes, pressure again builds up in the pipe equal to the boiler pressure, and it begins to open, only to pass through the same cycle of opening and closing, much like the action of an air hammer.

Pop-valve fluttering is a rather difficult thing to explain, and we are afraid that anyone following the advice inferred by the published answer to the question might have further trouble. We are soon issuing a folder on pop-safety-valve problems, giving instructions for installing and operating, which will take up this subject in detail.

J. W. TRACY,
American Schaeffer & Budenberg Corp.
Brooklyn, N. Y.

EDITOR'S NOTE—It is obvious that space does not permit the answers to "What do you know" questions to cover all contingencies. The answer given did, however, cover the most usual cause of valve fluttering.

What Made the Motor Howl?

In the article "What Made the Motor Howl?" by C. Dickerson, appearing on page 852 of May 31 issue, the experience related looks like a good case of trouble in the rotor of a squirrel-cage motor, due to grounds on the winding. However, it is doubtful if the new wedges held the bars tightly in the slots at all points.

I am inclined to think that the trouble was due to vibration of the bars in the slots, and this seems to be substantiated by the fact that the noise occurred when changing from high to slow speed. During this period there is a heavy current in the rotor bars, and the magnetic forces set up are considerable. If the bars are not held tightly at all points, then they will vibrate and produce the noise to which reference has been made.

There is no question about the fact that reinsulating the rotor bars cured the trouble, but I also believe that if the insulation had been left out entirely and bars used large enough to fill the slots, this also would have cured the trouble. Of course, reinsulating was the cheapest way of doing the job and the correct one. In most all modern motors of small and medium size no insulation is used in the slots. In fact, in some cases the windings are cast in the slots in one piece, bars and end rings.

I would also be skeptical of the welding between the rings and bars, except for the fact that the motor's torque was not affected. Most of the end rings are welded to the rotor bars so that the winding can be taken out of the slots only by cutting the bars clear of the rings, and when this is done it will require a new winding. Apparently, the way the end rings were welded to the bars of this motor, the rings could be removed without injuring the winding.

There is the possibility that on account of the rotor windings being grounded at a number of points, there was, during the period of heavy current in the windings, when the rotor was being slowed down, an unequal distribution of the current through the core that caused the noise. However, in my opinion this is only a possibility. I know of cases where wound-rotor motors have been noisy in their operation, and it was found that the rotor winding was grounded in a number of places. Removing the ground cured the trouble, but this is an entirely different condition from that in a squirrel-cage motor. In the wound-rotor machine voltages of considerable value obtain between two or more grounds in the winding, particularly if they are in different phases.

It is a well-established fact that grounds on the rotor bars of squirrel-cage motors have little or no effect on the torque of the motor. However, as to the effects of grounds causing noisy operation, particularly under the conditions cited by Mr. Dickerson, this has not been so well established. It would be interesting to have the opinion of some of those who are in a position to give expert advice on this performance.

Philadelphia, Pa. C. O. MILLS.

Removing a Pump Liner

The letter by H. L. Wheeler in the March 15 issue on "Removing a Pump Liner," reminds me of a visit to a small plant where a duplex pump was being used to discharge water to an open tank and with practically no head pressure on the discharge.

I noticed, when asked by the man in charge to have a look over the pump, that it was laboring hard. The engineer told me that it had not been working right for some time and that he had examined it but could find nothing wrong. Finally, I consented to examine the pump at intervals so as not to cause any interruption in the operation of the plant.

Following the usual practice in checking over pumps of this type, I disconnected the rocking arms and took bumping marks on each end of the steam cylinders and found the crosshead settings to be correct.

I then attached the rocking arms and put them all central, removed the cover of the valve chest, and found the valves were also set correctly. Upon trying out the pump again, there was no improvement in the speed or operating condition. I then removed the cylinder cover to see if the pistons were tight on the rods.

Upon removing the cylinder head, the trouble was at once apparent. The gasket, which was continuous over the whole head, had blown out in the narrow part between the cylinders, permitting the steam to bypass from one cylinder to the other. Consequently, when the pump was running the pressure in the working cylinder was reduced and at the same time a back pressure was built up in the other. When a new gasket was put on, the pump worked satisfactorily.

I have seen this trouble with double-cylinder revers-

ing engines which also had a continuous cover and joint. Leaks of this kind give no suspicion from the outside other than that there is something wrong. Care must be taken when cutting this type of joint, as the space is very narrow. Also, the nuts on the cover should be pulled up from time to time in order to avoid internal leakage between the two cylinders.

Aguathuna, Newfoundland. R. K. WALSH.

How About the Power Losses Outside the Power Plant?

The editorial, "An Engineering Job Partly Done," in the May 3 issue, hit upon something that is fundamental in the generation and transmission of power. The efforts that have been made to increase efficiency in the production of power, by improved design and operating technic is commendable, and the results obtained are a tribute to the engineers who have been responsible for these accomplishments. While these improvements have been taking place in the power plant, the efficiency in the transmission and use of power has received only a small part of the attention it merits.

A common cause of large power losses is using wire that is too small. This not only results in unnecessary power losses, but frequently is the cause of poor service and loss in production. A factor frequently overlooked where wire is run in conduit, is that often the size of the wire can be increased without increasing the size of the conduit. For example, if it were found that three No. 6 wires were required, according to the National Board of Fire Underwriters regulations, 1¼-in. conduit will have to be used. These regulations also allow three No. 3 wires to be pulled into this size conduit. In this case the size of the line can be doubled for the additional cost of wire only. In most cases the increase in size will be found to be a good investment. This increase in wire size will reduce the copper losses one-half, give better voltage regulation and provide additional capacity, which may at some time be desirable.

Wiring is installed under all sorts of conditions, but little attention is given it, as a general rule, after installation. If it is in a wet place, generally the first knowledge the operator has that something is wrong, is a short-circuit that puts the line out of commission. In one case, where open wiring was in a wet place and was poorly installed and maintained, putting one line in condition reduced the switchboard ammeter reading about 100 amperes. If it had not been that the plant was being overhauled and put in good operating condition, the leak on the wiring would probably have continued until a short-circiut or a dead ground occurred, before anything would have been done to correct the trouble. Even then the chances are that only the fault would have been repaired and no attention given to the poor condition of the system's insulation.

Leaks to ground are a function of the insulation's resistance. Although those responsible for some of the larger installations are keeping careful check on line and equipment insulation, the practice is by no means as general as it should be. Ground lamps are frequently used on switchboards to indicate if a ground occurs on the system. These lamps are all right within their limitations, which is only to show a ground on the system. If the ground occurs suddenly, as when one conductor comes in contact with a grounded part, the ground lamps will show the whole story. Many grounds occur, due to a gradual deterioration of the insulation over a long period, and this the ground lamps will not show. For this reason the switchboard should have a high-grade voltmeter arranged so that it can be connected to indicate volts drop through the insulation on the different legs of the circuit. Variation in the insulation resistance will be indicated by the voltmeter and can be easily traced and corrected if necessary.

The foregoing works all right on an ungrounded system, but where the neutral or the common leg of the system is permanently grounded, then the different parts must be disconnected and insulation tests made by one of the well-known methods. In any case a careful check should be kept on the insulation of the circuits and equipment, not only to avoid undesirable power leaks, but to detect and repair weak spots in the system before they cause serious trouble and expense.

New York City. M. E. WAGNER.

Answers to What Do You Know*

Ans. 1—The entire draft control should be obtained by manipulation of the stack damper.

Ans. 2—The head sheets can, theoretically, be one-half the thickness of the shell, but to afford holding power to the tubes the head thickness is increased slightly above the calculated value.

Ans. 3—This is to give a cushion for the piston and so stop pounding. The piston over-rides the first port, which leads to the exhaust cavity, so that the exhaust steam trapped between the piston and cylinder head is compressed by the advancing piston and by the cushioning, stops the piston without pounding. The second port communicates with the live steam port in the valve seat and live steam passes down this port to force piston on the return stroke.

Ans. 4—There are two systems in general use: (1) The unit system, in which one machine receives the raw coal without drying, pulverizes and delivers it to the furnace with the necessary air for combustion; (2) the storage system, in which the coal is prepared in a separate building or separate compartment of the boiler-house structure and is stored in bins until required.

Ans. 5—The reaction releases heat and the temperature will rise unless a cooling agent is used.

Ans. 6—The heat value of anthracite per pound of combustible is from 14,600 to 14,800 B.t.u.

Ans. 7—Dulong's formula for the air needed for combustion is:

$$W = 11.61\,C + 34.78\left(H - \frac{O}{8}\right)$$

When C = weight of carbon, H that of the hydrogen, and O of the oxygen in the coal. It is seen that the necessary air increases as the hydrogen increases.

Ans. 8—As the pressure in pounds per square inch is not determined by the area of the standpipe, but by its height, both the standpipes will exert the same pressure when the water levels are at the same point.

Ans. 9—Lubricating oil is a mixture of hydrocarbons of varying boiling points and will evaporate when heated. The percentage evaporated depends upon the nature of the oil, and the lighter constituents will be lost first, leaving the oil heavier than before it was heated.

Ans. 10—The De La Vergne Machine Co. built a surface-ignition, or semi-Diesel, oil engine in 1893.

*The questions will be found on page 872.

Power Plant Insurance

Facts about types of policies and losses covered, compiled by the United States Chamber of Commerce for policy holders or those contemplating such insurance

PROPER protection against the financial loss through plant accidents may be obtained to cover each type of apparatus for which insurance is desired. Each policy must specify a certain amount of insurance as a maximum limit in case of an accident to one or more objects insured, such as boilers, engines, etc. If personal injury is to be included with the property damage coverage, then a definite amount must be stated in the policy as the limit of liability for any one person. This limit is part of and not in addition to the total limit of liability under the policy. Usually, the policies contain a provision under which the full limit of the policy automatically is restored immediately upon the occurrence of a loss, so that the original amount of insurance, without diminution, again is made available for any subsequent loss that may occur during the policy term. These policies are usually issued in the following form:

(1) *Boiler and Pressure Vessel Policy:* Covering loss caused by the explosion, collapse or rupture of any power boiler, electric steam generator, portable boiler, steamboat boiler, track locomotive, cast-iron boiler and heater, as well as pressure vessels, such as steam pipes, air pipes, digesters, economizers, gas tanks, radiators, refrigerating apparatus and other vessels which are subjected to internal pressure.

(2) *Wheel Policy:* Covering loss or damage caused by the sudden stoppage and accidental bursting or dislodging of wheels while revolving, into two or more parts where one or more of said parts shall then be completely separated or dislodged from the other part or parts of the wheel.

(3) *Engine Policy:* Prior to the introduction of engine insurance, flywheels were insured. But the engine proper exclusive of a flywheel was not covered. This created a demand for complete coverage of steam engines and reciprocating machines which was met by the modern engine policy. This form of contract is written to cover loss caused by the breakdown of engines and reciprocating machines, such as pumps, air compressors, ammonia compressors and gas compressors.

(4) *Turbine Policy:* Generally, this is written to insure the entire unit against loss caused by explosion or breakdown. By a turbine unit is meant the complete apparatus of driving steam turbines and driven objects mounted with the steam turbine on a common bed and having a continuous shaft or shafts connected by means of couplings or reduction gears. It does not include any piping connected to it, nor the condenser, nor any other vessel or apparatus connected to it by pipe or wiring and not actually mounted and wholly supported on its bed.

(5) *Electrical Machinery:* This covers loss caused by the breakdown or burn-out of any generator, motor, transformer, rotary converter, switchboard, etc. This form of insurance is one of the latest additions to the insurance field and was first written in this country in a small way in 1920. The demand for it is rapidly increasing. Unlike boiler insurance, where the principal damage is caused to surrounding property and the boiler itself is but an insignificant part of the loss, the insured electrical machinery is itself the expensive piece of property most likely to suffer damage.

Kinds of Loss Covered

Generally, the policy provides for direct damage whether it covers the boiler, engine, wheel, turbine or electrical machine. By direct damage is meant that damage to property and injury to persons caused immediately, directly and solely by the explosion or breakdown of such objects. The power-plant policies are very similar; many of their conditions are identical and, as printed, each covers specifically the same kinds of loss arising from direct damage as follows:

(1) Loss or damage to the equipment itself.

(2) Loss or damage to other property of the assured.

(3) Loss or damage to the property of others for which the assured is liable.

(4) Loss on account of the liability of the assured for death or injury to persons not in his employ and for his liability to employees, if not in conflict with state compensation acts.

(5) The policy also provides for the defense of suits, even though groundless, brought against the assured, because of any accident covered by the policy. In addition it provides for the payment of court costs assessed against the policyholder in such litigation as may ensue between the policyholder and the person claiming damages, and interest accrued after entry of judgment until the company has paid, tendered, or deposited it in cost of judgment or in part thereof.

Use and Occupancy

While damage to such machinery and premises from a physical standpoint would constitute a direct loss, the inability to occupy and use the premises or the machinery might impair the earnings of the future and thereby constitute an indirect but, nevertheless, actual loss. To protect an insured against this indirect but actual loss, a standard use and occupancy indorsement may be attached to the policy. In consideration of an additional premium, therefore, this indorsement provides for the payment of a specific amount per day for each day of total non-production caused by the accident and arranges to pay a proportional amount based on the conditions of the indorsement for each day of partial non-production. These indorsements usually contemplate a maximum number of days during which full daily indemnity may be paid.

It is generally understood that use and occupancy insurance of the character covered by the indorsement attached to the power-plant policies provides for payment of the actual loss of net profits and fixed charges and expenses which necessarily continue during a temporary shutdown of the property.

The daily indemnity is usually determined by estimating in advance the probable use and occupancy loss taking into consideration those expenses which would continue in the event of a total shutdown of a plant. Sometimes the daily indemnity is determined by taking the average daily income and deducting from it those items of expense which could be immediately terminated in case of an accident, such as ordinary labor, power, raw material, etc.

Consequential Loss

This insurance against indirect loss may be provided for under an indorsement attached to the policy. In contrast with use and occupancy insurance, consequential loss or damage affects real tangible property. It usually follows direct loss. To illustrate: An accident has occurred to a refrigerating system in a cold storage plant. The freezing temperature necessary to prevent the spoiling of the stock of meat cannot be maintained. The temperature of the cooling room slowly rises and eventually spoils the meat. These perishable goods have not been destroyed or mutilated by the direct force of an explosion of the refrigerating system, but they spoiled as a result of the explosion to the refrigerating system—consequently the loss of the perishable goods is termed indirect loss.

Power Interruption

This is a new form of insurance which is also known as "Electric Current Interruption Insurance." It affords coverage against loss arising from the total or partial interruption of usable electric current and lighting

or power when such interruption is caused by an accidental breakdown of the physical equipment of a public-service electric light and power system from which such current is derived.

Kinds of Loss not Covered

Generally power-plant policies do not cover loss or damage:

(1) If due to a breakdown or explosion caused by fire or if loss or damage is caused by fire outside of the machine resulting from a breakdown or explosion.

(2) If the safety valve, which regulates the pressure, is set to allow a pressure in excess of that authorized, or if any device regulating the speed is set to allow a speed in excess of that authorized. On the other hand, if the speed or pressure regulating device has become defective, accidentally resulting in an accident, the loss is covered by the policy.

(3) If the loss is due to stoppage of plant or any other indirect result of a breakdown or explosion; if the accident occurs to an electrical machine while undergoing tests, experimentation, repairs or if its caused directly or indirectly by inundation, strike, riot, or civil commotion.

(4) The company shall not be liable for the value of, or the renewal or repair of any part of the equipment which has broken or failed because of deterioration or weakness of such parts produced by wear.

Engineering Inspection Service

A very important thing about power-plant insurance, aside from indemnity for loss, is the inspection service rendered by the insurance company. This service is provided in the form of regular and thorough inspections of all insured equipment. Such inspections are made by engineers especially skilled in the detection of flaws, which if left undiscovered, may result in an accident and serious financial loss. The inspecting engineer also instructs the operators of the equipment in better and safer operating methods, as well as to check the maintenance methods in the plant, to be sure the equipment is not allowed to deteriorate to the point of breakdown or explosion.

Water-Power Development Not Always Economical

AFTER discussing the many obstacles placed in the way of water-power development by government controversies, W. H. Onken, Jr., editor of the *Electrical World*, in an address, "The Hydro-Electric Power Era," before the fifteenth annual meeting of the United States Chamber of Commerce, Washington, D. C., May 2-5, said in part:

Our national water-power policy is embodied in the Federal Water-Power Act, and while this provides for recapture after fifty years and is favorable to government and all subdivisions of government, it does not shut the door to private initiative and enterprise. That the policy enunciated in 1920 is rational and enlightened is proved by the millions of horsepower which have been developed under its provisions. It is one of the most outstanding and constructive pieces of legislation enacted by any Congress, and every effort should be made to safeguard it.

Water Power Can Never Entirely Displace Steam

There is no industry more deserving of encouragement than that devoted to hydro-electric development but all water power is not susceptible to economic development, nor is there sufficient water power for all industrial purposes, nor does water power necessarily mean cheap power, nor can it be assumed that water power will or can entirely displace steam power.

Millions of undeveloped water power in Oregon and Washington are, because of the present state of the art of electric transmission, of no use to New York or Pennsylvania. Even electricity from the waters of northern New York cannot be developed and transmitted under present conditions to compete with steam power at tide water in New York City. Out in California transmitted hydro-electric energy generated in the high Sierras is no longer as cheap as steam-generated energy in Los Angeles, owing to the improved economy of modern super-power steam stations.

Steam Versus Water Power

There are very definite limits to the ability of water power to compete with steam power in the present state of the art, notwithstanding that our huge water-power systems have almost reached the acme of perfection so far as efficiency is concerned and super-power steam stations have not yet approached that point. For that reason steam stations are increasing in size and output at a greater rate than hydro-electric stations, and unless many water-power sites are developed at once, they may not be developed for many years to come.

Yet there is a persistent popular notion that any waterfall can be converted hydro-electrically into a never-ending stream of gold. The actual cost of electricity at the power house is only a small item in the total cost of the service. In a hydro-electric station the average cost of electricity may be very small indeed—the cost of transmission, distribution and service being many times the cost of the electricity itself. In fact, if the electricity were to be delivered at the switchboard free, the reduction in cost thus made possible to the ultimate consumer would be almost negligible. The same general proportion is true for steam-generated electricity with the exception that steam stations in large centers rarely require transmission networks.

A steam station can be erected at any place where fuel can be readily secured and where large quantities of water are available for condensing purposes. In the case of water power, however, the energy must be developed where nature provides the water, and if the location is too far from possible markets, it may be cheaper to erect a steam power station. In such a case that particular water-power site will remain unharnessed until its power can be used economically as part of a power reservoir in a large interconnected system.

The Modern System of Power Production

The remarkable economies made in the power costs of fuel-burning stations have brought about such savings that some water powers can no longer be developed on a competitive basis and the dollar differential in favor of fuel power increases yearly both on account of new economies in fuel-burning stations and because labor, material and land values in water-power developments continue to rise in price.

Steam station production costs at a water-power site are competitive with water-power costs in many instances. If, as is usually the case, the costs created by transmission lines are added to the water-power costs, the total water-power costs measured at energy delivery points, are greater as a rule than those involved in building and operating steam stations at the points where the loads exist.

I would not have you conclude from the foregoing that there is little hope for future hydro-electric developments. The opportunities, on the contrary, are as great as ever, but the development of large steam and water-power plants and the improvements made in the transmission of power have raised new problems as to the most economical methods of operation.

New power projects must hereafter be considered and studied in combination with existing power plants. The ultimate development of our water powers involves interconnection of existing stations if maximum use is to be made of them and the developments are to be profitable. Both for the conservation of the fuel supply and the economic advantages resulting from the use of power in our industries, development of all possible water powers and their interconnection with the existing systems should be encouraged.

Rochester Electric Prepares for New Generator

Construction of a foundation for a 23,000 hp. hydro-electric generator is in progress at Station No. 5 of the Rochester Gas & Electric Corp., Rochester, N. Y., below the lower falls of the Genesee River. This generator will be used to take advantage of an additional flow of water made possible by completion of the new dam at Court Street.

The new generator will replace four old water wheels with a total capacity of 11,000 hp., according to Roger D. Wolf, assistant superintendent of the electric department of the company. Machinery and installation will cost approximately $1,250,000, Mr. Wolf said.

Operating Experience with High-Pressure Steam at Edgar Station*

By I. E. MOULTROP† and E. W. NORRIS‡

THIS paper, based on experience with the high-pressure steam installation at the Edgar station of the Edison Electric Illuminating Company of Boston, discusses the operating difficulties encountered and describes an extension to the original installation.

STUDIES in connection with the design of this station, some four years ago, indicated that for the simple regenerative cycle, high pressure presents small gains, and hence a normal working pressure of 350 lb. per sq.in. was selected. When reheating was considered, on the contrary, the limitations were largely removed and higher pressures became more desirable. There appeared to be no limit except that of commercial design. It was decided to install a 1,200-lb. unit of such size that it could be kept continuously loaded at full capacity. The pressure was the highest for which commercial equipment could be obtained. The 1,200-lb. plant consists of one boiler and one 3,000-kw. turbine, with superheater and reheater.

No official tests have been run to demonstrate the performance of the high-pressure unit, but operation with and without it shows that it decreases the fuel rate of the plant about 4 per cent, which indicates that if the entire plant were built for high-pressure units, the saving would be about 12 per cent.

Operating Experience

The cross-drum boiler has water tubes 15 ft. long, 2 in. diameter, on 4-in. centers. Because of the closer spacing there is a tendency for slag to accumulate on the lower tubes at heavy loads. There was some trouble initially with the handhole gaskets. Difficulties in controlling the feed by hand have been eliminated by the use of feed regulators. Experiments carried out to determine the resistance to foaming demonstrated that no trouble would be experienced unless the water level were nearly at the top of the glass, an extreme condition not expected in normal operation.

Safety valves have proved as reliable as those operating at much lower pressures. Pilot safety valves installed to give warning at a pressure well below the popping pressure of the main valves were found to be unnecessary, and have been removed.

The economizer is of the plain steel-tube type and operates at boiler pressure. Semi-metallic gaskets for the handhole covers gave trouble and have been replaced by compressed asbestos, which has proved entirely satisfactory. There has been no other trouble with the economizer.

The furnace is similar to those serving normal-pressure boilers. Underfeed stokers are used, and the furnace is constructed of solid firebrick. An arch used to adapt the furnace to the short boiler tubes gave some trouble until it was ventilated. Owing to the reduced surface exposed to the fire, the furnace tends to run slightly hotter than those of the normal-pressure boilers, and slagging troubles are somewhat emphasized at heavier loads.

In the turbine the original carbon block shaft packing failed, causing serious vibration and was replaced by labyrinth packing, which has been successful. Further details of the condition of the turbine after some 1,800 hours of service were reported in *Power* for June 15, 1926, p. 925.

Special generator windings installed in the expectation that the high-pressure turbine would be difficult to govern were early found to be unnecessary, and since they promoted vibration in the generator, the original special rotor was replaced by a rotor of standard design, and vibration has been thereby eliminated.

Only the feed pumps of the multi-stage, single-suction type are of special interest, and these have performed with entire satisfaction, but show a tendency toward rapid wear of the hydraulic thrust-balancing surfaces.

The nozzle and throttle valve used to transfer steam from the high-pressure system to the normal-pressure system, bypassing the high-pressure turbine, have been entirely satisfactory both at full capacity and when running throttled. There have been no difficulties of any kind with either piping or valves.

After nearly two years of operation there seems to be no difficulty in handling high-pressure steam with apparatus of the conventional type made proportionately heavy, if great care be exercised in the design and in the selection and inspection of materials. In fact, there is an excellence of response in the equipment that has been found to render this part of the plant especially convenient to operate.

Extension to Edgar Station

In designing the extension to the station, it proved desirable to plan for normal-pressure units of 60,000 kw. capacity rather than 30,000, as in the initial installation. The operation of the high-pressure plant had shown satisfactory reliability and an approximation to the expected efficiency. In addition, the actual cost of installation checked the original estimates which indicated this part of the plant could be installed for approximately the same unit cost as the normal-pressure equipment. It was accordingly decided to plan the first extension of the station for the use of high-pressure steam. Two high-pressure boilers are being installed, with a 10,000-kw. high-pressure turbine and a 65,000-kw. normal-pressure unit. Auxiliaries will be driven electrically from a 5,000-kw. generator added at the end of the main unit. Steam headers will be installed so that any of the high-pressure boilers and turbines can be operated with any of the normal-pressure units, thus giving maximum flexibility.

The high-pressure turbines are to be governed by a double governor actuated either by the speed of the unit or by the pressure in the 350-lb. steam header. In starting, the pressure element will be put out of operation, and the unit will be synchronized with the speed governor in the usual way. Then the pressure governor will be put in operation and the speed governor setting will be increased so as to put it out of operation except as an overspeed governor. The turbine will then operate to maintain a constant pressure in the normal-pressure steam header.

Possibilities of Pressures Above One Thousand Pounds

The efficiency of any power installation depends primarily upon the efficiency of the steam cycle and upon the effectiveness with which this cycle is realized. With appropriate modifications in turbine design it is possible to maintain approximately the same turbine efficiency for all initial pressures. Similarly, by properly proportioning the surface of the boiler, economizer and air heater, marked increases of pressure have been made without sacrificing boiler efficiency. The power required by auxiliaries, however, increases rapidly with pressure, especially the boiler feed pump power, and at very high pressures it becomes a serious consideration and tends to limit the advantages of such pressures. The authors conclude that the efficiency of the basic steam cycle remains the prime element in station economy.

Problems of High-Pressure Equipment

The design of high-pressure equipment presents problems of mechanical strength and the effect of high temperature on the physical characteristics of materials. Present practice

*Abstract of paper on "High-Pressure Steam at Edgar Station," presented at A.S.M.E. Spring meeting.

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limits the maximum temperature to 750 deg. F. The desirability of using higher temperatures rests largely on the improvement in efficiency due to supplying dry steam to the turbine's lower stages, and much the same effect can be secured by reheating the steam during its expansion. The problem then lies in the choice between extremely high initial temperatures and more moderate temperatures with reheaters. It seems probable that the plan selected will depend largely on the cost of equipment.

In auxiliary equipment the most serious problems are in the boiler-feeding equipment and the steam and water valves. Thus far, however, the valves in service have shown no unusual tendency to deterioration. It is difficult to design pump casings and shaft packings that can be maintained tight at the extreme pressures required, there is, however, reason to expect that designs already worked out will alleviate these difficulties.

It is noteworthy that the high-pressure equipment is installed in a normal-pressure plant without the provision of additional space. This tends to offset the higher unit cost of equipment, but it should not be forgotten that as the pressure increases the corresponding gain is at a slower rate. The highest pressure that is of economic value will probably increase slowly as the cost of fuel rises and experience makes higher temperatures more convenient. For the present, however, the studies made indicate that there is little inducement to increase the pressures now in use.

The Economics of Coal Carbonization in the United States

AT THE fuel session of the A.S.M.E. Spring Meeting, held at White Sulphur Springs, G. A. Orrok[1] presented in his paper, "The Economics of Coal Carbonization in the United States," an outline of the development of coking coal and a discussion of the economic aspects of the industry.

He stated that the carbonization of bituminous coal was practiced in England early in the sixteenth century, when pit coal was burned in heaps similar to the charcoal kilns. The product of the carbonization, coke, was first used in England as fuel in the blast furnace about 1740 and had practically driven the charcoal furnace out of England in 1796. It was not, however, until 1841 that McCormack and Campbell secured a coke contract in Pittsburgh and built the first two coke ovens in the Connellsville region. The use of coke did not spread quickly, and by 1855 only about 100 coke ovens were in operation in the United States.

The history and progress of the carbonization industry had been so intimately connected with the metallurgical industry, and, in fact, with the production of pig iron, that the curves of pig iron produced and coal carbonized are practically identical when the proper scales are used.

It has long been known that the coking process as practiced in the beehive oven was wasteful, and many attempts have been made to utilize the wasted heat in a more efficient manner. In Europe, where coal was more costly and the necessity for saving more apparent, these early attempts to improve the beehive oven led Simon-Carves and others to experiment with other forms of ovens in which the carbonization process could be carried on in a shorter time without affecting the quality of the product and to which the new ideas of recuperation of regeneration could be applied. Incidentally, it was found that valuable byproducts might be saved in such quantities as to pay a portion of the construction and operating costs of the process. In France, Germany and England these experiments were successful, and in 1893 the Solvay Co. built the first bank of byproduct coke ovens in this country.

Better designs of regenerators and methods of heating have made savings in the quantity of gas used to heat ovens, increasing the quantity of surplus gas which was being increasingly used as a fuel in the open-hearth process with excellent results. Very large quantities of tar were also used for open-hearth and other furnace firing, less than half the output being sold to the tar-distillation companies. The other byproducts are ammonium sulphate and light oils.

Analysis shows that American coals vary in nitrogen content from about 0.50 per cent to nearly 2 per cent, corresponding to a theoretical range of from 47 to 188 lb. of ammonium-sulphate equivalent per ton of coal processed. The recovery varied between 10 and 30 lb. Some of the nitrogen went into the tar as phenolic and cresolic compounds, the remainder being lost in the coke and gas as elementary nitrogen or cyanic compounds.

Carbonization may take place at very low temperatures. Parr reported in his experiments a certain giving off of gas as low as 250 deg. F. The commercial low level was 660 deg. F., and from here to 1,300 deg. F. was the field of the low-temperature process. Above 1,300 deg. all coking might be termed high-temperature up to the 2,100-deg. wall temperature reported by Mr. Marquand. Temperatures in parts of the beehive and byproduct ovens are probably much higher than the 2,100 deg.

Low-temperature carbonization has been in use in some of its many forms for a considerable period and with varying degrees of success. The great obstacles that have hindered progress are mechanical difficulties and thermal difficulties. The mechanical difficulties have arisen through the necessity of handling hot, sticky, plastic materials, and the evil of hard, graphitic deposits. The thermal difficulties arise through the reduced temperature gradients and resultant troubles of heat transfer. Neither of these difficulties have been surmounted, but efficient design is progressing toward the solution of the one, and the recognition of certain principles, such as that of using thin layers of coal to facilitate heat transfer, are pointing to the solution of the other.

Low-temperature carbonization obtains more tar at the expense of less gas than the high-temperature process, also, the lower temperature yields less ammonia, and through the absence of cracking a higher thermal value of gas, which naturally yields more light oil on scrubbing. The refining loss is also higher because of the larger quantity of unsaturated hydrocarbon compounds.

The financial status of low-temperature coking was closely allied to its economic aspects. The coke in most cases was too fragile for blast-furnace use; in some cases it was fit for the foundry, and in the domestic fuel market it had to compete against its own raw material, bituminous coal. It was claimed that the great outlet for low-temperature coke was the electric central stations where the yield of byproducts could be credited to lowering the fuel cost. The disposal of large quantities of gas was also a perplexing problem. Low-temperature tar, after the extraction of light oil, was of questionable value. Tar distillers were doubtful of its value to them, but some authorities held out hope of utilizing its high creosotic content in the wood-preserving industry. The only assured market was that of a fuel oil sold on a B.t.u. basis. The ammonium sulphate would probably realize a small profit, but the effects of large quantities upon the market could not be predicted. Little difficulty should be encountered in disposing of light oil as motor fuel.

The best discussion of the byproduct process had been written by Dr. G. Klingenberg under pressure of war times. He found that the direct firing of coal was always superior to its gasification when coal cost more than $1.50 per ton and when the income from byproducts amounted to less than $1.62 per ton. From this, one could conclude that byproduct plants for German bituminous coals having small nitrogen contents were not feasible. Also coals having an average content of nitrogen could only be gasified under the assumption that the sulphate price remained at its normal height.

Meanwhile, the improvement in the economy of power generation had been such that processed fuel was not as attractive as was the case at the time Klingenberg's paper was written. Load factors had not greatly improved, although advantage had been taken of all available diversity. The best commercial results were still secured with generation as close as possible to the centers of heavy demand. In general, that combination of fixed charges, overhead and operating cost secured by the simpler combinations, which insured continuous service and an adequate return, was the best for the country as a whole, and to that portion of the public supporting the industry.

[1] Consulting Eng. N. Y. Edison Co.

Recent Publications

Der. Schiffsmaschinenbau (zweiter Band). By G. Bauer. Published by R. Oldenbourg, Munich and Berlin, 1927. Size, 8x11 inches; 623 pages, with folded Mollier diagram for steam. Price, 54 Marks in paper covers, 58 Marks in cloth.

This is the second volume of a masterly work. The first volume, which appeared some months ago, covers the theory and design of reciprocating steam engines and other ship machinery. This second volume covers the theory and construction of steam turbines and transmission machinery, with 18 chapters in the Appendix covering a number of related topics. The volume should be valuable to the designer of steam turbines and ship-propulsion machinery, and to students of those arts. The treatment seems unusually full and clear, with numerous apparently new and ingenious methods of presenting various details of the subject-matter.

The J. & P. Transformer Book. By S. Austen Stigant and H. Morgan Lacey. Published by Johnson & Phillips, Ltd., Charlton, London, S.E. 7, England. Cloth; 6½x9 in.; 400 pages; 275 illustrations; 27 tables.

Although this book is published by an electrical manufacturing company, it is not in any way a catalog, but an engineering treatment of power transformers, which is now in its third edition. The subject has been limited to oil-immersed self-cooled types, but much of the work is applicable to the power transformers in general. The construction descriptions have been confined to the circular core type, except so far as it has been necessary to consider the rectangular shell type in connection with certain aspects of operation. Testing transformers and static balancers have also been considered, but instrument transformers, reaction coils and induction regulators have been omitted.

Among the eighteen chapters that the users of transformers will find of interest is one dealing with transformer inquiries and tenders, which indicates the data the customer should give the manufacturer so that the latter may quote intelligently and expeditiously in accordance with the customer's requirements. This chapter and another dealing with transformer and oil specification make a comprehensive treatment on the purchase of transformers. There is also an appendix that gives the British Engineering Standards Association specifications for transformer oil. Four chapters on transformer connections are included, and six chapters on testing installation, protection and maintenance of transformers and the treatment of insulating oil form a valuable part of this book.

The treatment, naturally, represents British practice, nevertheless much of the material is applicable to transformers in general. Some of the chapters are of a nature that will be understood by electrical engineers only, but a large part of the material on the purchase, operation and maintenance if of a character that can be comprehended by those whose electrical knowledge is limited to a practical training.

Repair-Shop Diagrams and Connecting Tables for Induction Motors. By Daniel H. Braymer and A. C. Roe. Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City, 1927. Cloth; 6x9 in.; 232 pages; 161 illustrations; 50 tables; 27 charts. Price, $2.50.

Where induction motors are changed from one locality to another, a change in the winding may be necessary to satisfy a change in voltage, the number of phases or the frequency or any combination of these. Where the electrical characteristics of the motor are suitable for the new circuit, the speed of the motor may not be correct for the load and will require changing by regrouping the old winding or by putting a new winding in the motor. There are, also, many problems that present themselves to repair men and armature winders when grouping the coils of alternating-current motor windings.

In this book practical step-by-step information and instructions are given for connecting all types of windings for two-phase and three-phase motors having from 2 to 24 poles for use by armature winders in electrical repair shops when rewinding and reconnecting induction motors, and by maintenance men in industrial plants when changing existing winding connections. The first six of the 29 chapters give instructions on how to use the connection diagrams and charts. These include such subjects as: How to use the connecting diagrams; how to use the coil grouping charts and tables; how to work out unequal coil groupings; how to lay out and check up two-phase diagrams; how to lay out and check up three-phase diagrams; and directions for using tables for connecting ends of groups. The other 20 chapters comprise chiefly charts, tables and diagrams for a wide variety of two- and three-phase motor windings.

The diagrams are for the type of windings commonly used in the stators of induction motors. Wave windings, such as used on phase-wound rotors, have not been considered. Even though these represent a small proportion of the induction motors in use, no doubt many practical men would like to have information on these types of windings, since comparatively little practical information on them is available.

In the treatment throughout the book the practical electrical worker and his limitations have been kept in mind, and the object has been to present the information so that it can readily be applied without any calculations. The authors have succeeded in bringing together a valuable collection of data on induction-motor windings that should find a large field of usefulness among practical electrical repair men.

Standards Year Book, 1927. A book of large value in the daily work of all officers and agencies concerned with standardization. By National Bureau of Standards, U. S. Department of Commerce. Cloth, 6x9¾ in.; 392 pages; price, $1.

The Standards Yearbook represents an effort to present an adequate picture of the diversification and ramification of the standardization movement which has spread throughout the world with astonishing vitality during the 25 years that have elapsed since the establishment of the U. S. Bureau of Standards. It contains outlines of the activities and the accomplishments not only of this bureau and other agencies of the federal government and the states and municipalities, but also of the American societies and associations of which standardization is a major or very important activity. Descriptions and illustrations are presented of all the fundamental national standards of the United States. Moreover, outlines are given of the various foreign, national, and the several international standardizing agencies.

As a companion volume to "Commerce Yearbook," which deals strictly with industry and commerce, the "Standards Yearbook" deals strictly with standards and standardization. In this volume are correlated the essentials concerning standardization activities with which the Bureau of Standards is in close co-operation, and the subject of standardization is presented in its entirety.

The "Standards Yearbook" will be most valuable in the daily work of all officers and agencies concerned with standardization, especially in its official or governmental aspects. It will furnish the answers to a great volume of urgent inquiries received by the Bureau of Standards from manufacturers, industries experts, engineers and purchasing agencies, both governmental and general.

In these days of increasing industrial standardization the engineer must keep in touch with all manner of developments. This volume should help him.

Water Resources Paper No. 51—The Dominion Water Power and Reclamation Service of the Department of the Interior of Canada has published a new volume of that portion of the series of water resources papers which deals with the surface water supply of Canada. This report is No. 51 of the series and gives details of stream measurements made in the province of British Columbia during the year from Oct. 1, 1924, to Sept. 30, 1925. The report contains a short explanation of the purpose and scope of the work and 278 pages of stream-flow tables and descriptions of gaging stations, with an index map of British Columbia showing their location. This report will be supplied free of charge on application to the Director of the Dominion Water Power and Reclamation Service, Ottawa, Canada.

News in the Field of Power

Brooklyn Edison's No. 5 Awarded Westinghouse

Unit No. 5 of the Brooklyn Edison's Hudson Avenue generating station will be completed and in operation about July 1, 1928, with the installation of the 108,700-kw. electric generator which was placed on order with the Westinghouse Electric & Manufacturing Co. June 1, according to the announcement of Matthew S. Sloan, president of the Brooklyn Edison Co.

"Though it is only a few months," said Mr. Sloan, "since we put in operation our No. 4 unit of 80,000-kw. capacity, the largest unit now in operation in this country, the growth of Brooklyn is so rapid and the demands for electric light and power increase so fast that already we find it necessary to order this unit of still greater capacity to keep pace with the expansion of the community we serve."

The new unit, which will be the largest ever built by the Westinghouse company, will have all its turbine blades of stainless steel. Its over-all length will be 80 ft., width 35 ft. 3 in. and height 24 ft. 3 in. The total weight will be 2,230,000 lb., while the weight of the largest single piece, one of the generator's stators, will be 210,000 lb. The unit will go in the space originally designed for a generator of one-half its capacity. The stators will be built complete with windings in the Westinghouse shops at Pittsburgh, Pa.

Like the No. 4 Unit the new generator will be of the cross-compound type and will operate under 400 lb. steam pressure at the boiler superheated to 725 deg. F.

A.S.M.E. Names Officers for 1928

Nominations for officers of the American Society of Mechanical Engineers for 1928 were announced at a recent meeting of the nominating committee held at White Sulphur Springs, W. Va.

Those presented as nominees by the committee are: for president, Alex Dow, president of the Detroit Edison Co.; for vice-presidents, John H. Lawrence, vice-president and engineering manager of Thomas E. Murray, Inc., New York City, Newell Sanders, Newell Sanders Plow Co., Chattanooga, Tenn., Edward A. Muller, vice-president and general manager of the King Machine Tool Co., Cincinnati, Ohio, and Paul Wright, Paul Wright & Co., Birmingham, Ala.; and for managers, William A. Hanley, chief engineer for Eli Lilly & Co., Indianapolis, Ind., Luther B. McMillan, chief engineer, Johns-Manville, Inc., New York City, and Fred H. Dorner, Milwaukee, Wis.

Election will be by letter ballot of the entire membership, closing Sept. 27.

Those presented as delegates to the American Engineering Council are: Alex. Dow, Detroit,; D. S. Kimball, Ithaca; R. C. Marshall, Washington; L. P. Alford, New York; H. V. Coes, Chicago; William S. Lee; Charlotte; A. M. Green, Jr., Princeton; David W. Brunton, Denver; and John L. Harrington, Kansas City.

Flood Control Seen as Aid to Swing-Johnson Bill

Advocates of the Swing-Johnson bill see in the forthcoming flood-control legislation an opportunity to advance the Boulder Canyon project. Representative Swing has been very active in Washington during the high-water period. He is now with the Flood Control and Commerce Committees on their trip down the river. It is these committees that will write the new flood-control bills which will be laid before Congress. Evidently, it is the plan to try to put through Colorado River legislation along with that applying to the Mississippi.

Despite the enterprise of the Swing-Johnson advocates it is apparent that there will be difficulties to overcome. The Mississippi Valley representatives have no objection to the inclusion of the $160,000 needed to protect the Imperial Valley against flood, but they will fight efforts to tack onto their bill the opposed Boulder Canyon bill.

The spectacular debate during the closing days of the last session had the effect of focusing public attention on the issues involved. There is abundant evidence that the public has learned that there is no excuse for spending money of federal taxpayers on the Colorado River, as private capital has expressed its willingness to relieve flood danger and take care of irrigation needs in return for the privilege of developing the power. While consumers of hydro power are objecting to the saddling on them of such costs as irrigation and flood control, it is an advantage to the federal taxpayer.

Exhaust Steam Injector Wins Scott Award

Award of $1,000 and the John Scott Bronze Medal was made to Strickland L. Kneass, mechanical engineer, of Philadelphia, Pa., June 2.

This fund was created in 1816 by the will of John Scott, a Scotch chemist, who lived in Edinburgh and was inspired to establish the trust by similar acts of Benjamin Franklin.

Mr. Kneass, who is manager of the inspection department of William Sellers & Co., Philadelphia, Pa., receives the award for the invention and development of an exhaust feed water heater injector with its accessory valves and the method of regulation and operation.

A.I.E.E. Plans Busy Summer Convention in Detroit

A well balanced schedule of papers and a program of attractive recreational features will mark the coming summer convention of the American Institute of Electrical Engineers, which will be held at the Book-Cadillac Hotel, Detroit, Mich., from June 20 to 24.

For the technical sessions many papers on practical operating subjects have been chosen, as well as some of the latest scientific contributions. All branches of electrical engineering will be covered by the reports of the technical committees.

For the entertainment of the visitors, golf and tennis tournaments are planned, together with boat trips, dancing, receptions, teas and sports for the ladies and inspection trips to Fordson plant, Trenton Channel and other plants of interest. Arrangements may be made for a lake trip after the convention.

Alex Dow is chairman of the general convention committee, with G. B. McCabe as vice-chairman. G. H. Roosevelt is chairman of the entertainment committee, J. W. Bishop of the hotel committee, and F. H. Riddle of the registration committee.

Papers of Special Interest to Power Engineers

Monday, June 20, the first day of the convention, is to be devoted to registration and section conferences. On Tuesday morning the convention will be opened and at 10: 30 a technical session will be held. Here will be presented papers on the Holtwood steam plant by F. A. Allner; "Auxiliary Power Supply for Richmond," by J. W. Anderson; "Recent Investigations of Transmission-Line Operation," by J. G. Hemstreet, and "Use of High Frequency Currents for Control," by C. A. Boddie. In the afternoon golf and tennis tournaments are scheduled, and in the evening is a lecture on "The Physical Nature of the Electric Arc," by Dr. D. T. Compton, followed by the president's reception and dance.

Wednesday, June 22, will be devoted to the reports of the technical committees, with a trip to Trenton Channel in the afternoon and a dinner in the evening.

On Thursday, June 23, another technical session is scheduled with papers on ocean cable telegraphy, electrical reproduction of sound, high-voltage multiple conductor joints and others.

Morning and afternoon technical sessions are to be held on Friday, June 24. Papers will be presented in the morning covering corona loss, insulating materials and mercury arc rectifiers. The afternoon session will be of particular interest to railway engineers, as it will be devoted almost entirely to papers on catenary suspension.

A.I. & S.E.E. Convention and Show, June 13-18

An exposition of iron and steel products—the power show of the iron and steel industry—held in conjunction with the twenty-third annual convention of the Association of Iron and Steel Electrical Engineers, will open for the week of June 13, at Syria Mosque, Pittsburgh, Pa.

Exhibits will consist of electrical, mechanical combustion and safety apparatus used in connection with blast furnaces, open-hearth furnaces, blooming mills, finishing mills, power houses, byproduct coke ovens, illumination, transmission, welding, heat-treating, maintenance shops, transportation, etc.

A symposium and a number of important technical studies will contribute the main features of the convention sessions, which will be held in the Pittsburgh Athletic Association Annex.

Following registration and business session Monday morning, electrical developments in the iron and steel industry will be the topic of W. H. Burr, and in the afternoon, under the session of the Safety•Engineering Division of the A.I. & S.E.E., "Safety Practices in Connection with the Operation of High Tension Power," by A. N. Cartwright, West Penn Power Co.; George E. Gramm, H. C. Frick Coke Co.; and Thomas E. Hughes, Carnegie Steel Co., will be considered. Next in order will be a discussion by the Safety Division and electrical engineers and superintendents of iron and steel plants, central stations and mines. In the evening the exposition will be officially opened.

To Discuss Anti-friction Bearings

Attention Tuesday will be centered on the symposium devoted to "Anti-Friction Bearings for Heavy Duty Steel Mill Applications With Particular Reference to Roll Necks," by F. W. Cramer, Bethlehem Steel Co.; C. J. Klein, United Engineering & Foundry Co.; F. H. Buhlman, Rollway Bearing Co.; E. C. Gainsborg, Engineering Dept., SKF Industries, Inc., New York, and Fred Waldorf, the Timken Roller Bearing Co. Following this, "The Application of Synchronous Motors in Steel Mills," by Harry A. Winne, General Electric Co. will take the floor.

"Recent Boiler Plant Installation at Edgar Thomson Works, Carnegie Steel Co., Braddock, Pa.," will be offered by R. D. Abbiss, special engineer at those works, during the morning of June 15. In the evening the annual dinner dance for members and guests will be held at the Schenley Hotel.

An inspection trip of the new structural mills of the Homestead Works of the Carnegie Steel Co., at Munhall, Pa., will be made Thursday afternoon, June 16.

Declares Federal Regulation Is Not Needed

A defense of the holding company as a necessity for large electric power interests operating in different states was made by Col. George T. Buckingham, general counsel for the Illinois Power & Light Corp. in a recent address at Topeka, Kan. He spoke at the annual dinner of this Midwest section of the National Electric Light Association.

Colonel Buckingham also asserted that state regulation of electric power corporations is satisfactory, complete and fully protects the interests of stockholders and the public. He declared that there was neither need nor demand for Federal regulation.

Copco Unit No. 2 To Rise on Rogue River

The California-Oregon Power Co. development work in southern Oregon, under construction or ordered, will entail an expenditure of $5,000,000. This does not include a proposed further development that will mean an additional expenditure of another million. The projects included are:

Construction of another unit at Copco No. 2 on Rogue River near Prospect announced May 23 by the H. M. Byllesby Co. of Chicago.

The third unit of the Prospect plant is contemplated but not ordered.

The building of the second unit at Prospect will make available 44,000 hp., making it the largest plant in the Copco system. When the third unit is completed, it will be 66,000 horsepower.

It is expected that the Prospect project will be completed and in operation by Jan. 1, 1928.

G. E. Elects Three New Heads —Two Executives Retire

Election of three new vice-presidents and the retirement of two executives of the General Electric Co. were announced by Gerard Swope, president, following a meeting of the board of directors of the company in New York on May 25.

C. C. Chesney, manager of the Pittsfield works, W. R. Burrows, associate manager of the incandescent lamp department, and C. E. Eveleth, manager of the Schenectady works, were elected vice-presidents of the company, taking on responsibilities in the manufacturing department. F. C. Pratt, vice-president in charge of manufacturing, and H. F. T. Erben, assistant vice-president of the manufacturing department, have retired. The officers of the company were re-elected at the meeting.

Berlin Opens New Electric Plant Rivaling Parisian

The Klingenberg electric plant, with a capacity of 300,000 kw., which will supply 75 per cent of Berlin's electrical power, opened officially May 14 in the presence of government, state and city officials. The new plant is fitted with the most modern labor-saving devices and most efficient machines, enabling the three shifts to be operated by a staff of less than two hundred men.

Two turbines turn the generators. The plant is fitted with reserve units of the same size. It is pointed out that the present plant, which has the same capacity as the Vitri works in Paris, is operated with a crew one-tenth in size.

Illinois Wins Round in Lake Michigan Diversion War

Motion by the State of Illinois and the Sanitary District of Chicago to strike a paragraph from the suit of the State of New York involving the diversion of water from Lake Michigan, was upheld by the Supreme Court in a brief decision rendered May 31.

In its suit, New York State alleged that diversion of water through the Sanitary canal at Chicago was detrimental to the interest of New York in various ways. One paragraph alleged that diversion tended to prevent development for power purposes of the Niagara and St. Lawrence Rivers, to the detriment of New York State and its citizens.

Illinois and the Sanitary District moved to strike out the allegation as indefinite and the Supreme Court holds that this should be allowed on the ground that New York now is not being injured in power development on an international stream.

Super-Pressure Steam Plant for Bradford, England

The Bradford Corporation, England, has placed a contract for the extension of its Valley-road station by a boiler and a turbine plant to operate at a pressure of 1,100 lb. per sq.in. The English Electric Co. has the main contract, while Babcock & Wilcox will handle the boiler construction.

The plan outlined by the city of Bradford comprises a boiler with a maximum evaporative capacity of 94,000 lb. of steam per hour at a pressure of 1,100 lb. per sq.in., and a temperature of 800 deg. To utilize the steam at this pressure there is to be a 2,500-kw. geared turbo-alternator, the exhaust from which, at a pressure of 210 lb., will be delivered into the existing main steam range of the station, to serve as live steam for the existing turbines.

Wisconsin Control Over Power Dams Upheld

The Wisconsin State law which requires owners of power dams to apply to the State Railroad Commission for authority to continue operation, and in their application agree to sell to the state or a county or municipality under certain conditions, was upheld May 31 by the United States Supreme Court in a decision by Justice Stone in the appeal of the Fox River Paper Co. and others, against the Railroad Commission.

In 1925 the Wisconsin Legislature passed a law requiring operators of power dams to apply for a permit and stipulating certain conditions. The Fox River Paper Co. and its associates applied for a permit, but omitted the agreement regarding sale to a public agency under the conditions stipulated under the law. The suit resulted.

The State Supreme Court upheld the law, and this decision was affirmed by the United States Supreme Court, which points out the sovereignty of a state over navigable streams subject to the higher authority of Washington.

New R. Project Ruled Under Federal Jurisdiction

Power development on New River, near Radford, Va., comes within the Federal Power Commission's jurisdiction, according to action taken at a meeting of the Commission June 1, in connection with a declaration of intention filed by the Appalachian Electric Power Co., which proposes to construct a dam 1,600 ft. long and 115 ft. high. A reservoir nineteen miles long with a storage capacity of 100,000 acre-feet will be created.

The Commission did not take jurisdiction, however, over a small development in the North Fork of New River. S. A. Lawrence, of Cleveland, proposes to construct a dam 25 ft. high at a point near Weaversford, N. C. The capacity of the proposed reservoir and the fact that it is 246 miles above the head of navigation, led to the conclusion that the development would not affect the navigable capacity of the Kanawha River.

Secretary Jardine, one of the members of the Federal Power Commission, was recently in the Radford region and reports that the project has strong local support. It is expected that the Commission will authorize the issuance of the license at its next meeting.

The project was initiated with the filing of a declaration of intention in 1925 by the New River Development Co., the predecessor in interest to the Appalachian Co. The original applicants strenuously opposed the taking of jurisdiction by the Federal Commission. The Governor of West Virginia, however, insisted that the Commission take jurisdiction because of the effect of the Kanawha River where important navigation exists. The Commission finally took jurisdiction in the case and will insert conditions in the license calculated to safeguard navigation.

Favorable report on the application has been made by the Chief of Engineers.

A preliminary permit was ordered issued to George T. Cameron to cover a 100,000-hp. project involving a number of small lakes and creeks in the Tongass National Forest near Juneau, Alaska.

Simplifies Russian Purchases of American Equipment

Fox Brothers International Corp., a subsidiary of the exporting firm of Fox Bros. & Co., Inc., of 126 Lafayette St., New York City, announces that it has made arrangements with banking interests in New York and London which will insure a credit against acceptance documents on Russian purchases to the amount of $5,000,000 for the current year.

Under this arrangement American exporters will be paid in cash for Russian purchases. It is stated that the corporation was formed to facilitate purchases of engineering equipment and offer things of which the Soviet government is in urgent need in the American market. Under existing economic and industrial conditions the Russian government cannot pay cash for its requirements and American manufacturers do not feel warranted in extending the long-term credits that are necessary.

John J. Teal, vice-president of the corporation, says there is a strong sentiment in Russia for goods of American manufacture, especially in lines of mechanical equipment.

Wage Earner's Production Grows 35 Per Cent

The total manufacturing production in the United States has increased about 65 per cent in volume from 1914 to 1925, or at a rate about 3½ times as fast as the population, which has increased less than 18 per cent during the same period, according to a study just completed by the National Industrial Conference Board, 247 Park Ave., New York City. The production of manufacturing industries per wage earner employed in 1925 was 35 per cent, or more than a third, greater than in 1914, volume of production having far outstripped the increase in the number of workers as well as population growth.

In these figures, in the view of the Conference Board, lies the chief explanation for the unparalleled growth of our national wealth and income and our national business prosperity, which rests primarily on the rising productive and purchasing power of the American wage earning population. "Real wages," that is, the weekly earnings of industrial workers as measured by living costs, since 1914 have increased about 33 per cent, while the "real" national income, as measured in dollars of constant purchasing power, has increased about 28 per cent, indicating that the wage earner during that period has shared the increase in income at about the same rate as the nation as a whole.

Technical improvements, increased managerial efficiency, including, above all, the much increased use of mechanical power, the Board declares, in the main have been responsible for the increasing productivity of our industries. In 1925 there was 32 per cent, or nearly a third more installed power back of every factory worker in the United States than there had been in 1914. The greater amount of production thus turned out per worker employed, the Board points out, has made possible the maintenance of a high wage level during a period of declining prices, an anomaly in the light of previous experience which has puzzled economists and business men both in America and abroad.

Injuries Less in Utilities

Manufacturing industries were responsible for 41.4 per cent of the 99,673 injuries for which final awards for compensation were made in New York State during the fiscal year July 1, 1925, through June 30, 1926. Construction, with the next largest number of cases, was responsible for 20.5 per cent of the compensated cases during the same fiscal year. The number of cases in the transportation and public utilities group amounted to 17.7 per cent of the total.

Considers Connecting Systems

In order to connect the system of the Indiana Electric Corp. at Indianapolis with the Columbia station of the Columbia Power Co., on the Ohio River, near Cincinnati, a 132,000-volt line is under consideration, according to official announcement from the offices of the Indiana Electric Corp.

Obituary

G. A. Meckel superintendent for Wm. B. Scaife & Sons Co., Oakmont, Pa., died suddenly at the home of his daughter in Frederick, Md., May 16. On May 26 of this year Mr. Meckel would have completed 64 years of continuous service with the Wm. B. Scaife & Sons Co., 51 of which he served as general superintendent of the mill. During his association with the company he developed and perfected many improved methods in tank construction. It is believed that his length of service sets a record for continuous employment by any one company in the State of Pennsylvania if not nationally.

John H. Macalpine, consulting marine engineer, died at his home, May 31, 18 Swetman Ave., Mount Vernon, N. Y. He was in his sixty-eighth year. Mr. Macalpine was born in Paisley, Scotland, and was educated at the University of Glasgow. He passed much of his time in Great Britain in connection with marine construction work and was employed at various times by virtually all of the big steamship lines and the United States Navy Department. He wrote several papers on marine construction and was recognized as an expert on steam turbines, a gear for which he invented. He first came to the United States in 1902. He had been living in Mount Vernon eight months, and before that in Philadelphia.

Personal Mention

H. C. Blake has resigned as president of the Foos Gas Engine Co., Springfield, Ohio. His resignation takes effect June 7, and after a vacation, his first in ten years, he will re-engage in the engine manufacturing business.

Owen D. Young, chairman of the board of the General Electric Co., will be the chairman of the American delegation to the Stockholm meeting of the International Chamber of Commerce, June 27 to July 2, it has been announced by the American section.

Wallace Clark, member of the American Society of Mechanical Engineers, has received the Commanders Cross of the Order of Poland Restored for his services in connection with the reorganization of tobacco and salt monopolies of Poland. Mr. Clark was the engineer member of the Kemmerer Finance Commission which visited Poland in 1926 at the invitation of the Polish government. The honor was bestowed on May 13, 1927, in New York, by the Polish minister to the United States.

H. W. Cooper, for the last three years manager of the Pasco-Kennewick district of the Pacific Power & Light Co. in the State of Washington, has been transferred to the Lewiston, Idaho, district as manager, a vacancy left by the resignation of R. H. Jenks.

F. W. Peek, Jr., who has been a consulting engineer in the transformer department and in charge of the high-voltage testing laboratory of the General Electric Co., has been named engineer of the general transformer department.

H. W. Hardinge, president of the Hardinge Co., has been awarded the Edward Longstreth Medal by the Franklin Institute of the State of Pennsylvania for his invention of a rotary air classifier, known as the Hardinge reverse current air classifier.

Chester W. Rice, who has been engaged in development work in the research laboratory of the General Electric Co., has been named assistant to E. W. Allen, vice-president in charge of engineering. Mr. Rice will give special attention to new developments.

W. S. Moody, in general charge of the transformer engineering department of the General Electric Co. since its inception, has been appointed a consulting engineer for all transformer departments of the company and for all departments of the Pittsfield works.

Society Affairs

A.S.M.E., Detroit Section dinner and meeting at 6:30 at Detroit Engineering Society Club, June 15. H. B. Tyree, fuel agent for the Detroit Edison Co. will speak on "Coal."

American Society for Steel Treating, Hartford Chapter, will hold its eighth annual banquet at the City Club, Hartford, Conn., 6:30 p.m., June 7. Hon. Herbert Knox Smith, of Farmington, Conn., will speak on foreign relations. Clayton R. Burt, vice-president and general manager, Pratt & Whitney Co., will be toastmaster.

Business Notes

The Lincoln Electric Co. announces a complete line of all-steel, ball-bearing polyphase induction motors, ranging in size from 1 to 100 hp. in all standard voltages and cycles in which gray iron and malleable castings have been entirely replaced by hot rolled steel.

The American Electric Switch Corp., Minerva, Ohio, which has been organized and incorporated with J. C. Lewis, president, Arthur Koch, treasurer, and E. F. Rinoehl, secretary, at an authorized capitalization of $1,000,000, will manufacture a large and varied line of safety switches, fuse panels, panel boards, switchboards and distribution panel boards for industrial plants.

Coming Conventions

American Association of Engineers. Annual convention, Tulsa, Okla., June 6-8; M. E. McIver, 63 East Adams St., Chicago.

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Order of Steam Engineers. Annual convention, Moose Hall, 1314 North Broad St., Philadelphia, Pa., June 13-16; J. E. Burke, 1821 So. Ringgold St., Philadelphia.

American Society of Civil Engineers. George T. Seabury, secretary, 33 West 39th St., New York City. Annual convention at Denver, Col., July 13-15.

American Society for Testing Materials. Annual convention at French Lick Springs Hotel, French Lick, Ind., June 20-24; J. K. Rittenhouse, secretary, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

Association of Iron and Steel Electrical Engineers. Annual convention at Pittsburgh, Pa., June 13-18, inclusive.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27; John Topman, secretary, convention committee, Ohio State annual convention in Memorial Hall, Lima, Ohio, June 16-18; P. H. Grigsby, secretary, Lima, Ohio. New England States convention at Portland, Me., June 17-18; Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass., Hartford meeting June 24-25, business sessions Saturday morning, aviation flight and banquet.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., June 14-16 inclusive.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Convention at Atlantic City, June 6-10; exhibition, June 4-10.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

The General Electric Co. has appointed an engineering council. This body includes E. W. Rice, jr., honorary chairman (ex-officio); E. W. Allen, chairman; Elihu Thomson, A. C. Davis, W. R. Whitney, W. L. R. Emmet, C. C. Chesney and C. E. Eveleth. The purpose of the engineering council is to advise with the vice-president in charge of engineering. The council may invite other engineers to meet with the council, and at such times may give them the status of regular members.

The Climax Engineering Co. announces the appointment of the James McGraw Co., Richmond, Va., as its sales agent in Richmond and vicinity. The James McGraw Co. travels a number of salesmen throughout Virginia and North Carolina.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	May 30 1927
Pool 1	New York	$2.50@$3.00
Smokeless	Boston	1.70
Clearfield	Boston	1.60@ 1.85
Somerset	Boston	1.75@ 2.00
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.75@ 1.90
Pittsburgh	Pittsburgh	2.00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.45@ 1.60
Franklin, Ill.	Chicago	.....
Central, Ill.	Chicago	.....
Ind. 4th Vein	Chicago	.....
West Ky.	Louisville	1.40@ 1.60
S. E. Ky.	Louisville	1.40@ 1.75
Big Seam	Birmingham	1.50@ 1.90
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.35@ 3.00
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.40@ 1.60

FUEL OIL

New York—June 2, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—May 25, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.70 per bbl.; 26@28 deg., $1.75 per bbl.; 28@30 deg., $1.80 per bbl.; 30@32 deg., $1.85 per bbl.; 32@36 deg., gas oil, 4.12c. per gal.; 38@40 deg., 5.24c. per gal.

Pittsburgh — May 26, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.

Philadelphia — May 25, 27@30 deg., $2.25@$2.31 per bbl.; 13@19 deg., $1.75 @$1.81 per bbl.

Cincinnati — May 31, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—May 21, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., 97½c. per bbl.; 26@30 deg., $1.05; 30@32 deg., $1.12½.

Boston—May 28, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@32 deg., 5.8c. per gal.

Dallas—May 27, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Trade Catalogs

Power Hoe—The Link-Belt Co. has issued Booklet No. 666 on its power hoe designed as an improved drag scraper for salvaging coal.

Transformers — Westinghouse Electric & Manufacturing Co.—Circular 1688-B, begins with a discussion of the application of various forms of distribution and small power transformers. It continues with several pages of halftone illustrations showing the construction of the various parts. The last two pages of the circular contain some new and interesting charts depicting the application of various kinds of transformers, depending upon the kva. rating and the voltage classification.

Celite for Concrete—The Celite Products Co., 11 Broadway, New York City. This bulletin gives the up-to-date information on the use of Celite in concrete, including a discussion of the use of Celite where the water-cement ratio is specified. The bulletin includes considerable data of general interest on the subject of concrete construction with particular reference to the effect of workability on the uniformity, strength, watertightness, permanence, and appearance of the concrete.

Pressure Filters—The International Filter Co., water softening and filtration plants, 333 West 25th Place, Chicago, Ill., has published Bulletin 252 on filtration in connection with the pressure filters manufactured by the company.

Centrifugal Pumps—The Dean Hill Pump Co., manufacturer of pumping machinery and steam turbines, Anderson, Ind., has issued Bulletin No. 403 which describes in detail the construction of a new line of ball-bearing double-suction bronze-fitted centrifugal pumps manufactured by the company. Four illustrations elucidate the text.

Mechanical Installation of Electric Motors and Control—The General Electric Co., through the Small Motor division, Industrial Department, has issued Section PM-7162 of the Motor Dealer's Power Manual. Special consideration is given to such phases as location, including floor space, accessibility, atmospheric conditions, and type of drive; strength of support; rigidity of support; foundations; quietness; methods of mounting motors and control; and practical methods of aligning motors, embracing belts and chains, gears, and direct connection.

Galvanometers—Leeds Northrup Company, manufacturer of electrical instruments, has issued catalog No. 20 describing various types of sensitive laboratory galvanometers. It includes instructions for selecting the proper type, and precautions in using these moving coil instruments.

Paralleling Rectifiers—The Westinghouse Electric & Manufacturing Co. paralleling reactors type RR for 115 volts to 575 volts, and type SR for 2,300 to 6,900 volts single phase are described in Leaflets Nos. 20317 and 20316 respectively. Both of these leaflets describe the design, operation and construction of these reactors and contain tables of adjustment for different reactances. Wiring diagrams and halftone cuts complete these leaflets, which may be obtained at any of the district offices of the Westinghouse company or from the Department of Publicity at East Pittsburgh.

New Plant Construction

Calif., Bakersfield—Padre Hotel Corp., H. H. Schister, Pres., awarded contract for the construction of an 8 story hotel and stores building at 8th St. and Chester Ave. to John M. Cooper, 301 Rives-Strong Bldg., Los Angeles. Estimated cost $650,000. Steam heating and ventilation systems, electric elevators, etc. will be installed.

Calif., Coronado—Island City Hotel Co., c/o R. M. Bates, 660 South Vermont Ave., Los Angeles, Archt., is having preliminary plans prepared for the construction of an 8 story hotel including steam heating and refrigeration systems, elevators, etc. here. Estimated cost $850,000.

Calif., Davis—University of California, Berkeley, is having plans prepared for the construction of a central heating plant here. Estimated cost $50,000.

Calif., Los Angeles — Biltmore Hotel, Olive St., plans the construction of a 12 story addition to hotel. Estimated cost $2,000,000. Schultze & Weaver, 17 East 49th St., New York, are architects.

Conn., Greenwich—Sewer Commission, awarded contract for the construction of sewage pumping stations, A.C.E.G., Dist. 1, to Kuchar Bros., Montvale, N. J.

D. C., Washington—B. S. Simmons, 1013 15th St. N. W., Archt., is preparing plans for the construction of a 13 story hotel including vapor heating and refrigeration systems, four electric elevators, etc. Estimated cost $1,250,000. Owner's name withheld.

Ill., Chicago—Chestnut—DeWitt Syndicate, c/o L. F. Urbain, 1254 Lake Shore Dr., Archt., is having sketches made for the construction of a 20 story apartment at Chestnut and DeWitt Sts. Estimaed cost $3,500,000.

Ill., Chicago—Henning Bood, 2664 East 76th St., will soon receive bids for the construction of a 5 story apartment including central refrigeration plant, vacuum heating system, elevators, etc. at Exchange Ave. and 76th St. Estimated cost $950,000. Thomas R. Bishop & Son, 35 South Dearborn St., are architects.

Ill., Chicago—J. Horwitz and H. J. Marlowe, 10 South La Salle St., is having plans prepared for the construction of an apartment and stores building including cooling plant at 119th St. and Eggleston Ave. Estimated cost $600,000. G. McClellan, 7441 Cottage Grove Ave., is architect.

Ill., Chicago—Komorous & Menke, 2130 West Lake St., are receiving bids for the construction of a 7 story hotel including central refrigeration plant, mechanical ventilation system, elevators, etc., at Kanore Ave. and Irving Park Blvd. Estimated cost $400,000. W. H. Pyrn, Jr., 122 South Michigan Ave., is architect.

Ill., Chicago—B. F. Lindheimer, 77 West Washington St., is having sketches made for the construction of a 22 story office and stores building at Jackson Blvd. and Franklin St. Estimated cost $2,000,000. A. S. Alschuler, 28 East Jackson Blvd., is architect.

Ill., Chicago—University of Chicago, 14 East Jackson Blvd., is having sketches made for the construction of a hospital on Campus Grounds. Schmidt, Gaeden & Erickson, 104 South Michigan Ave., are architects.

Ill., Decatur—A. Milner, 304 West Wood St., had plans prepared for the construction of a 14 story hotel including ventilation systems, elevators, etc. at 320 North Church St. Estimated cost $650,000. Private plans.

Ill., East Moline—State of Illinois, Capitol Bldg., Springfield, awarded contract for remodeling power plant at Watertown State Hospital here. to J. H. Hunzinger & Co., Security Bldg., Davenport, Ia. Estimated cost $49,780.

Ill., Freeport—Central Steam Heat & Power Co., J. H. Murphy, Secy., Madison, Wis., plans the construction of a steam heating plant and boiler house, etc. Estimated cost $500,000. L. J. Ashley, City Hall, Freeport, is engineer.

Ill., Geneseo—City, J. D. Darnall, Supt. of Schools, is having plans prepared for the construction of a new heating plant for South Side School. Estimated cost $25,000. C. J. Allen, Chicago, is engineer.

Ill., Rockford—Rockford Hotel Co., South Main St., is having plans prepared for the construction of a 10 story hotel at Wyman and Chestnut Sts. Estimated cost $1,000,000. Thielbar & Fugard, 219 East Superior St., are architects.

Ind., Indianapolis—Butler College, Fairview Park, awarded contract for the construction of three college buildings at 46th St. and Sunset Ave. to Hegeman-Harris Co. Inc., 431 North Michigan Ave., Chicago, Ill. Estimated cost $1,700,000.

Ind., Muncie—Challis Building, G. S. Challis, Wysor and Grand Sts., is having plans prepared for the construction of a theatre building including vapor heating and refrigeration systems, elevator, etc. Estimated cost $650,000. George & Zimmerman, 501 Meyer-Kiser Bldg., Indianapolis, are architects.

La., Arabi—The Arabi Packing Co. Inc., Parish of St. Bernard, is receiving bids for a 60 ft. tower with 30,000 gal. capacity tank to be erected at their plant.

Me., Portland — A. S. Friend Co., Inc., 285 Madison Ave., New York, N. Y., awarded contract for the construction of a 5 story office, stores and theatre building at Congress and High Sts., here, to J. D. Harrison Corp., 285 Madison Ave., New York, N. Y. Estimated cost $1,400,000.

Mich., Detroit—R. T. Lee, General Motors Bldg, is having plans prepared for the construction of an 11 story apartment including steam heating, refrigeration and ventilation system, boilers, elevators, etc., on Second Blvd. Private plans.

Minn., Moorhead—City will soon award contract for waterworks improvements including drilling of well, pumping equipment, etc. Estimated cost $15,000.

Mo., St. Louis — Bd. of Public Service plans the construction of a 6 story hospital including steam heating system, etc., at Park and St. Ange Aves. Estimated cost $1,200,000. L. R. Bowen, A. Osburg, and H. Updike, 301 City Hall, are architects and engineers.

N. J., Newark — L. Cahan, Bankers Trust Bldg., Philadelphia, Pa., is having plans prepared for the construction of a 20 story hotel including steam heating and refrigeration systems, boilers, elevators, etc., at South Broad, Camp and Chestnut Sts., here. Estimated cost $5,000,000. F. Grad, 1021 Broad St., Newark, N. J., is architect.

N. J., Newark—Steuben Society of Newark, 60 Park Pl., is having revised plans prepared for the construction of an 8 story club, theatre and stores building including steam heating, and refrigeration systems, boilers, elevators, etc. Estimated cost $800,000. F. H. Koenigsberger, 48 Walnut St., is architect.

N. J., Teaneck (mail W. Englewood)—Holy Name Hospital is receiving bids for the construction of a power house. Estimated cost $40,000.

N. J., West New York (Weehawken P. O.)—Burstyn & Hefler, 222 30th St., Woodcliff, plan the construction of a 10 story apartment including steam heating and refrigeration systems, boilers, elevators, etc., on Eastern Boulevard, here. Estimated cost $500,000. Private plans.

N. Y., Manlius—Manlius School, plans the construction of a group of buildings including central heating plant, etc. A. B. Trowbridge, 110 East 43rd St., New York, is consulting architect.

N. Y., New York—Rhinelander Estate, c/o F. M. Valk, 31 Nassau St., is having plans prepared for the construction of two 11 story apartments including steam heating system, etc. at Lexington Ave. 88th to 89th Sts. Estimated total cost $1,000,000. Sugarman & Berger, 345 Madison Ave., are architects. Lang & Moska, 420 Lexington Ave., are engineers.

N. Y., New York—Zimmer, Resnick & Locker, 285 Madison Ave., awarded contract for the construction of an 18 story hotel at 235-245 West 46th St. to O'Day Construction Co., 1639 Broadway. Estimated cost $1,000,000.

N. Y., Rochester—Monroe Tuberculosis Sanitorium, will soon award contract for the construction of a power house on West Henrietta Rd. Estimated cost $360,000. G. S. Wright, County Court House, is engineer.

N. D., Devils Lake—City, M. Olsen, Auditor, will soon award contract for waterworks improvements including reservoir, pump house, etc. Estimated cost to exceed $25,000.

N. D., Manden—Northern Pacific Ry. Co., Railroad Bldg., St. Paul, Minn., had plans prepared for the construction of a power plant including two 200 hp. and one 300 hp. water tube boilers, etc. here. Estimated cost $150,000. H. E. Stevens, is chief engineer.

O., Cincinnati—Fountain Square Building Inc., 2400 Gilbert Ave., plans the construction of a 16 story office building at 5th and Walnut Sts. Estimated cost $1,415,000. H. Hake, 2400 Gilbert Ave., is architect.

O., Kent—Bd. of Trustees, Kent Normal School, W. A. Cluff, Secy., will receive bids until June 23 for revamping electric system, pipes, etc. Estimated cost $75,000. Ronan & Ingleson, 1614½ North High St., Columbus, are engineers.

Oklahoma—Dierks Lumber & Coal Co., Dierks Bldg., Kansas City, Mo., is having preliminary plans prepared for the construction of a hydro electric plant and dam here. Estimated cost approximately $5,000,000. Private plans.

Pa., Bryn Mawr—Bryn Mawr Hospital, awarded contract for the construction of a hospital on Bryn Mawr. Ave. to Stone & Webster Inc., 120 Broadway, New York, N. Y. Estimated cost $2,000,000. Steam heating and ventilation systems, boilers, pumps, elevators, etc. will be installed.

Pa., Marcus Hook—Treasury Dept., Office of J. A. Wetmore, Acting Supervising Architect, Washington, D. C., will receive bids until June 21 for the construction of a boiler house including mechanical equipment for U. S. Quarantine Station here.

Pa., Philadelphia—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will soon award contract for the construction of an automatic refrigeration and cold storage plant at Navy Yard, here.

Pa., Pittsburgh—The Koppers Co., Union Trust Bldg., is having plans prepared for the construction of a 22 story office building at William Penn Way. Estimated cost $2,000,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., are architects.

Pa., Pittsburgh—Morewood Gardens Co., c/o V. C. Farrar, 1 Park Ave., New York, N. Y., Archt., will soon award contract for the construction of a 7 story apartment on Morewood Ave. Estimated cost $1,400,000. Marks & Kann, Home Trust Bldg., are associate architects.

Tex., Houston—J. H. Jones, is having plans prepared for the construction of a 35 story office building at Main and Rusk Sts. Estimated cost $4,000,000. A. C. Finn, Bankers Mortgage Bldg., is architect. R. J. Cummins, Bankers Mortgage Bldg., is engineer.

Tex., Port Arthur—N. M. Barrier, Port Arthur, and J. Hani, Beaumont, are having plans prepared for the construction of a 10 story hotel including steam heating, refrigeration and ventilation systems, boilers, elevators, etc. here. Estimated cost $500,000. J. R. Bailey, 1606 Main St., Houston, is architect.

Wis., Milwaukee—City, R. E. Stoelting, Comr., awarded contract for the construction of a boiler house at North Point pumping station to Worden Allen Co., Port Washington Rd. Estimated cost $120,000.

Que., Papineauville—T. Bonhomme has made application to Canadian Government for the construction of a dam and generating station. Estimated cost $50,000. Engineer not selected.

Que., Terrebonne — A. P. Whiteford, Montreal, has made application to Canadian Government, for the construction of a dam and generating station here. Estimated cost $100,000.

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Boiler — Treasury Dept., office of J. A. Wetmore, Acting Supervising Architect, Washington, D. C., will receive bids until June 20 for furnsihing and installing a new boiler in U. S. Post Office and Court House at Victoria, Tex.

Boilers—Bd. of Education, F. G. Hogen, Dir., Cleveland, O., will receive bids until June 20 for new boilers and replacing old ones in various schools.

Boilers—Dept. of Justice, Superintendent of Prisons, Washington, D. C., will receive bids until June 10 for boilers and auxiliary equipment for power plant at Atlanta, Ga.

Engine—Portland Southwest Mining Co., Las Cruces, N. M., plans to purchase a new Diesel engine.

Engine, Generator, Pump, etc.—City of Chetopa, Kan., will be in the market for a 350 hp. oil engine direct connected to 2,300 v., a.c. generator, also pump and motors for proposed improvements to waterworks and electric lighting system. Estimated cost $70,000.

Engine, Pumps, Motors, etc.—C. W. Hill, Clk., Imperial, Neb., will receive bids until June 10 for power plant building, 175 to 200 hp., 2 or 3 cylinder vertical Diesel oil engine direct connected to a 150 to 187½ kva. 3 ph., 60 cycle, 2,400 v., 257 to 327 r.p.m. and complete with either belted or direct connected exciter, one 125, one 200 and one 250 g.p.m. two stroke deep well pumps, one 250 g.p.m. centrifugal pump direct connected to a 15 hp., 3 ph., 60 cycle, 220 v. motor, 10 and 15 hp., 3 ph., 60 cycle, 220 v., 1,200 r.p.m. double squirrel cage motors complete with pulley and slide rails, etc., for proposed waterworks improvements.

Engines and Generators—Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., Columbus, O., will receive bids until June 28 for one 125 kw. and one 150 kw. engines and generators for Boyd Industrial School at Lancaster, O.

Generating Equipment, Boiler, etc.—B. Chamberlain, Clk., Pasadena, Calif., will receive bids until June 14 for furnishing and installing steam generating equipment, including 1,500 hp. boiler, etc., for municipal light plant.

Generators, Etc.—G. J. Dietz, Supply Comr., St. Louis, Mo., will receive bids until June 17 for two steam turbine driven generators for Howard's Bend waterworks on the Missouri River. Estimated cost $30,000.

Pump and Motor—City of Lone Wolf, Okla., will be in the market for a triplex pump and motor for proposed waterworks improvements. Estimated cost $30,000.

Pump and Motor—G. Herber, Mayor, Apache, Okla., is in the market for a 50 g.p.m. deep well pump and 5 hp. 220 v. motor.

Pumps, Etc.—City of Magnolia, Miss., will receive bids until June 10 for one 300 g.p.m., 15 hp. and one 450 g.p.m., 25 hp. motor driven service pumps, one 1,000 g.p.m., 100 hp. fire pump, etc., for proposed waterworks improvements.

Pumps, Etc.—City of Ada, Okla., will soon receive bids for pumps, etc. for proposed waterworks improvements. Estimated cost $45,000.

Pumps, Etc.—Wayne County Auditors, W. Gutman, Secy., County Bldg., Detroit, Mich., will receive bids until June 17 for two 500 g.p.m. motor driven centrifugal pumps, against 345 ft. head, etc. for proposed waterworks improvements at Northville, Mich.

Pumps and Motors—G. G. Meade, Clk, Arcadia, Calif., will be in the market for pumps and motors for proposed waterworks improvements.

Pumps and Motors, Etc.—R. L. Jones, City Hall, New Madrid, Mo., will receive bids until June 9 for two 150 g.p.m. centrifugal pumps and motors for proposed sewage pumping plant.

Refrigeration Machine — Division of Architects and Engineers, Capitol Bldg., Springfield, Ill., will receive bids until June 24 for refrigeration machinery for Illinois Eye & Ear Infirmary at 904 West Adams St., Chicago, Ill.

Switchboard—Bd. of Public Service, 208 City Hall, St. Louis, Mo., will receive bids until June 28 for a complete power and lighting switchboard for Howard's Bend Waterworks, at Hine, Mo. Estimated cost $11,000.